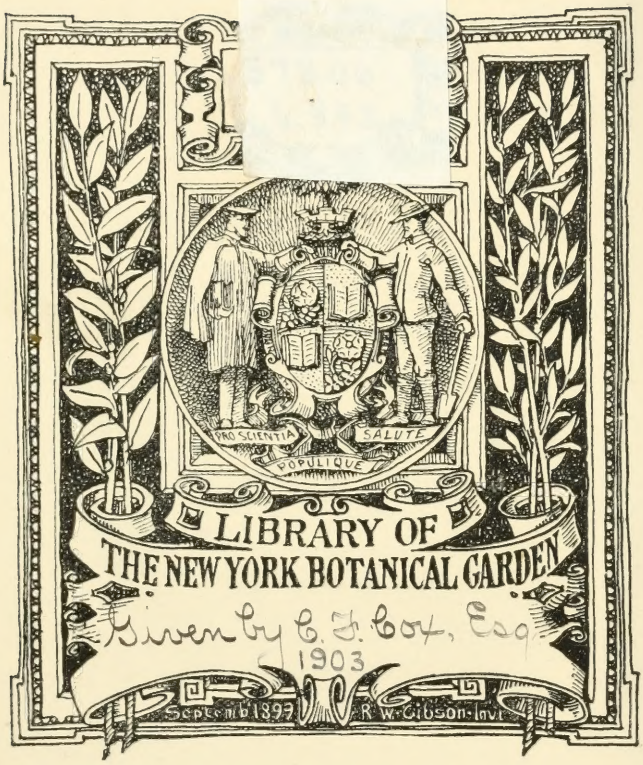
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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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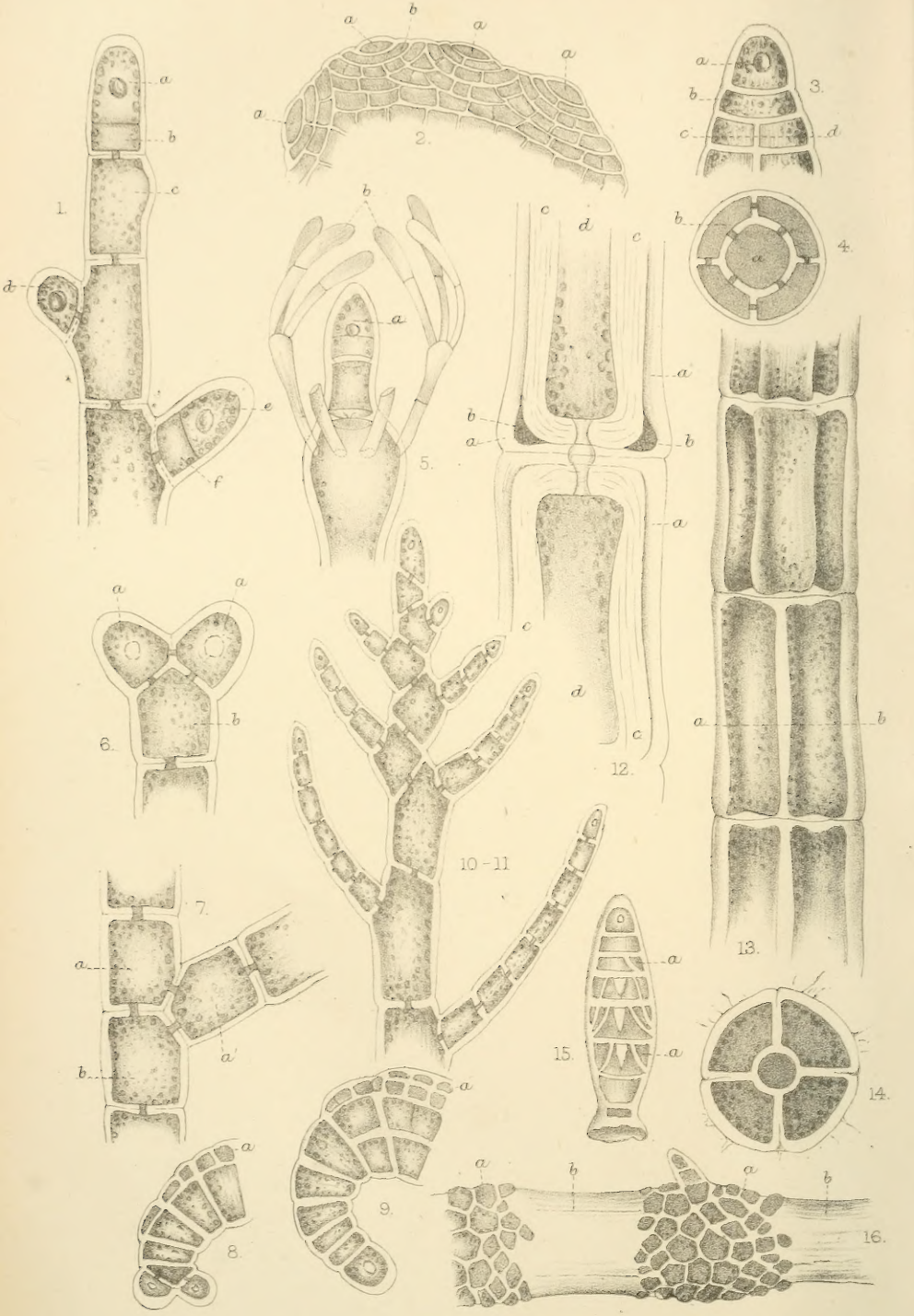

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1886.

TRANSACTIONS OF THE SOCIETY.

XI.—*Notes on the Structure and Evolution of the Florideæ.*

By George Massee, F.R.M.S.

(*Read 14th April*, 1886.)

Plates XII. and XIII.

Notwithstanding the marked variety of form and structure met with in the vegetative parts of *Florideæ*, an examination of the groups shows that there are but few types of structure, all of which can be traced back to a primitive form, illustrated by such genera as *Chantransia* Thur. (*C. corymbifera* Thur.) and *Balbiania*

EXPLANATION OF PLATES XII. and XIII.

Fig. 1.—*Trentepohlia virgatula* Harv. Showing apical cells, *a*, *d*, *e*, also the segment or daughter-cell just after segmentation, *b*, *f*. This figure also illustrates the mode of branch formation by lateral protrusions from cells behind the apical cell; at *c* the first indication of a lateral branch is shown. The branches are developed in acropetal order. × 300.

Fig. 2.—*Porphyra laciniata* Ag. Showing numerous apical cells, *a*, *a*, *a*, *a*; *b*, segment yet entire and watchglass-shaped. × 300.

Fig. 3.—*Ahnfeldtia plicata* Fries. Showing the origin of the multicellular thallus to be due to peripheral or pericentral cells cut off from an axial cell; *a*, apical cell; *b*, segment. × 300.

Fig. 4.—Transverse section through fig. 3 at the point *c*, *d*; axial cell *a*, pericentral cells *b*, connected by threads of protoplasm. Further back the thallus becomes thicker owing to the segmentation of the pericentral cells by radial and tangential septa. × 300.

Fig. 5.—*Halurus equisetifolius* Kzg. Showing the apical cell *a*, surmounted by the uppermost whorl of branches, *b*. × 300.

Fig. 6.—*Dasya coccinea* Ag. Illustrating the formation of branches by divisions of the apical cell; the two cells *a*, *a*, are the basal cells of new branches. If they develope equally, a dichotomy will result; *b* is the terminal cell of the podium from which the two branches *a*, *a*, originate. × 300.

Fig. 7.—*D. coccinea*. Illustrating monopodial branching, resulting from division of the apical cell. The cells *a*, *a'*, correspond to *a*, *a*, in fig. 6, but *a* continued developing in the same direction as the podium, of which *b* is the uppermost cell, while the sister cell *a'* grew at an angle. The cells *a*, *a'*, are each connected by protoplasmic threads with three other cells. × 300.

Figs. 8 & 9.—*Ceramium rubrum* Ag. Showing that the incurved tips of the

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Sirodot (= *Chantransia investiens* Lenor.), the latter a fresh-water species, in which the more or less branched thallus consists of single rows of superposed cells. In *Erythrotrichia* Aresch., generally included in this family on account of its red colour, the structure is yet simpler, consisting of an unbranched filament of single cells placed end to end; but as the organs of reproduction

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branches, characteristic of this genus, are due to local growth. The upper cells are wedge-shaped, and the corticating cells *a*, *a*, first appear on the broadest end of the wedge-shaped cells, thus causing the tip to curve. At some distance behind the growing point the thin end of the wedge-shaped cells grows fastest, and the corticating branches develope all round, pushing the stem back until straight. × 300.

Figs. 10 & 11.—*Callithamnion polyspermum* Ag. Showing the segmentation of the apical cell by oblique septa in the main axis. The segmentation of the branches is from the first by septa at right-angles to the axis of growth. × 300.

Fig. 12.—*Polysiphonia fastigiata* Grev. Section of axial cells, showing portions of protoplasm *b*, *b*, imprisoned between the primary layer *a*, *a*, and the secondary layers *c*, *c*, *c*, *c*, of the cell-wall; *d*, *d*, protoplasm of cells. × 600.

Fig. 13.—*Polysiphonia urceolata* Grev. Surface view, illustrating the type of stem composed of fascicles of cells of equal length. × 250.

Fig. 14.—Transverse section of fig. 13, through *a*, *b*, showing the axial and four pericentral cells. × 250.

Fig. 15.—*Ceramium rubrum*. Germinating spore, showing origin of adpressed corticating branches *a*, *a*. × 300.

Fig. 16.—*Ceramium flabelligerum* J. Ag. Surface view, showing corticating branches *a*, *a*; *b*, *b*, axial cells. × 250.

Fig. 17.—*Batrachospermum moniliforme* Roth. Showing the basal portions of two whorls of branches, which originate from the anterior end of axial cells *a*, *a*; *b*, *b*, free branches of whorls, the corticating branches are shown at *c*, *c*. The portion represented is near the tip of the stem, and the adpressed branches are as yet short, and few in number. × 300.

Fig. 18.—*Gloiosiphonia capillaris* Carm. Vertical section, illustrating the type of thallus composed of agglutinated branches. The axial cells are seen at *a*, giving off whorls of branches at *d*, *d*, which become densely branched, and at the tips composed of minute cells forming the "cortex" *b*. Some of the secondary branches do not grow towards the circumference, but parallel to the axis, as shown at *c*, *c*. × 250.

Fig. 19.—Transverse section of fig. 18, through one of the whorls of branches; lettering same as in previous fig. × 250.

Fig. 20.—*Lenormandia linearis* Harv. Illustrating the development of a flattened thallus from the cylindrical *Polysiphonia* type, due to local growth. In the apical region the section is circular, and consists of an axial and pericentral cells; further back, as shown in the fig., the lateral wings *a*, *a*, are the result of the continued growth and division of the pericentral cells, the anterio-posterior cells *b*, *b*, remain rudimentary. After Agardh, 'Floridearnes Morphologi,' tab. 33, fig. 17.

Fig. 21.—*Ptilota plumosa* Ag. Showing the development of a flattened thallus from the joining together of the "veins" which represent the outline of a simpler filamentous form, by a membrane; *a* axis, *b* lateral branches with pinnate arrangement. In this species the membrane only forms a broad wing to each vein. × 25.

Fig. 22.—*P. plumosa*. Surface view of one of the lateral branches, showing the axial row of cells *a*, from which all the other cells originate. × 250.

Fig. 23.—Transverse section of fig. 22, showing the development of the wing or membrane to be due to excessive growth and repeated division of the lateral pericentral cells. × 250.

Fig. 24.—*Delesseria* (*Wormskioldia*) *sanguinea* Lamour. Apical part of one of the leaf-like portions of the thallus, showing the main axis *a*, with pinnately

characteristic of the *Florideæ* are not developed, its true position is uncertain. For the same reason the genera *Choreocolax* and *Pseudoblaste* of Reinsch,* consisting of minute red filaments parasitic on or among the tissue of other algæ, are passed over, since it does not follow that every red or pink seaweed belongs to the *Florideæ;* hence *Chantransia*, from a morphological point of view, stands at the base of the group.

Harvey† divided algæ into three primary groups, *Chlorospermeæ*, *Melanospermeæ*, and *Rhodospermeæ*, distinguished by colour, the first being green, the second olive-brown, and the third various shades of red or purple. This method of classification has been entirely superseded by one which is almost entirely carpological; the structure of the organs of reproduction and fruit being considered of primary importance in determining the position of a plant in the system. The adoption of this later method has resulted in the entire rearrangement of the *Chlorospermeæ* and *Melanospermeæ*. The *Rhodospermeæ* still remain intact, but are now known as *Florideæ*, an older name than Harvey's, used by Agardh, and characterized by the presence of a more or less elongated filament called the *trichogyne*, which is the attenuated continuation of a cell known as the *trichophore*. When the motionless antherozoids are passively floated in contact with the trichogyne, they adhere to it, and fertilization takes place, followed by the formation of spores, either in the trichophore, or more

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arranged lateral branches, the whole resembling a feather-veined leaf. In this species the membrane is continuous, no space being left between the lateral branches, as in *Ptilosa plumosa*, fig. 21. Natural size.

Fig. 25.—*D. alata* Lamour. Surface view of growing point. Neglecting for the moment the membranaceous portion of the frond, we find a well-developed apical cell *a*, but of the type characteristic of the lower filamentous forms. For some distance behind the apex, the axis is composed of a single row of superposed cells, each axial cell giving origin to a pair of opposite monosiphonous branches; this arrangement recalls to mind such filamentous forms as *Callithamnion plumula* and *C. plumula*. Further back, the axial row is segmented into axial and pericentral cells *b*, or the *Polysiphonia* type is reached. At first the axial cells are very short, but as they elongate, the lateral branches are not separated but remain organically connected, and by cell-division give origin to the membranous portion, at the same rate of increase as the elongation of the axial cell. The first septa that appear in connection with the development of the membrane, are parallel to the axis of growth of the branch, and cut the single superposed row of cells of which it before consisted, into a posterior and an anterior row. The posterior row, by repeated cell-division, form the membrane, which when fully developed, consists of small polygonal cells; the anterior row of cells generally undergo no further division, but increase in length as the thallus becomes broader, so that they eventually appear as long narrow cells forming the lateral "veins" which are in the older portions, like the axis, cut into axial and pericentral cells *d*. The apical cell of each lateral "vein," by segmentation, adds to its length *c*. × 300.

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* 'Contributiones ad Algologiam et Fungologiam,' 4to, Norimbergii, 1874–5.

† 'Nereis Boreali-Americana,' 4to, New York, 1858.

frequently in specialized adjacent cells, which with the trichophore and trichogyne collectively constitute, before fertilization the *procarp*, and after fertilization the *cystocarp*. The discovery of this very remarkable and complicated reproductive apparatus is due to the extensive researches of Dr. Bornet and M. Thuret,* whose magnificent illustrations and lucid descriptions leave little more to be expected in connection with the reproduction of the *Florideæ*. In Agardh's latest work on *Algæ*,† *Porphyra*, *Erythrotrichia*, *Goniotrichum*, and *Bangia*, genera previously classed with the *Florideæ*, are included in the *Ulvaceæ*, one leading characteristic of which is the possession of true zoospores. From this it appears that he does not admit Berthold's statement ‡ that the species of *Porphyra* possess a trichogyne and trichophore, the latter eventually forming the cystocarp.

The genus *Chantransia* as defined by Thuret, contained both marine and fresh-water types, frequently to be met with growing on other algæ, under the form of minute tufts or velvety fringes, and characterized mostly by the monotypic structure of the vegetative parts; but a more extended and critical examination has shown that only two of the supposed species possess antheridia, trichogynes, and cystocarps; one fresh-water, *C. investiens* Lenor., made the type of a new genus, *Balbiania*, by Sirodot; the other a marine species, *C. corymbosa* Bornet, which is therefore the only true *Chantransia*. It has been shown by Sirodot § that many of the fresh-water organisms formerly included under *Chantransia*, are nothing more than the prothalloid stages of various species of *Batrachospermum*, a genus of fresh-water algæ belonging to the *Florideæ*, and morphologically but little above *Chantransia*.

It is interesting in connection with the development of the organs of reproduction characteristic of the *Florideæ*, to note that in the genus *Chantransia*, where they first appear, out of numerous forms which, as already explained, from an examination of the vegetative parts alone, appear to be good members of the genus, only two have succeeded in producing sexual organs; the rest after remaining some time as asexual forms, give origin as it were to a sexual generation in *Batrachospermum*, whose reproductive organs closely resemble those met with in *Chantransia* and *Balbiania*, but in this second generation the vegetative part has become rather more complex.

A repetition of what has been described is met with in *Callithamnion*, a typical Floridean genus in its most perfect develop-

* "Recherches sur la fécondation des Floridées," Ann. Sci. Nat., vii. (1867). 'Notes Algologiques,' fasc. i, ii., Paris, 1876–8.

† "Til Algernes Systematik," Lunds Arsskrift, xix. (1882–83) 177 pp. and 4 pls.

‡ Mittheil. aus der Zoolog. Station zu Neapel, iii. (1882) pp. 393–536, 3 pls.

§ "Observations sur le développement des algues d'eau douce composant le genre Batrachospermum," Bull. Soc. Bot. France, xxii. (1875).

ment; but towards the base of the genus we have *C. rothii*, in which antheridia and cystocarps are unknown, but characteristic tetragonidia (= tetraspores) are present; yet lower down we meet with plants agreeing exactly in thallus structure with *C. rothii*, but without cystocarps, and instead of producing tetragonidia, we find undivided gonidia produced in cells terminating lateral branches, and occupying exactly the same position as the tetragonidia in *C. rothii*. The species with undivided gonidia and no sexual organs, including the old *Callithamnion virgatulum* of Harvey, and others, now constitute the genus *Trentepohlia*. The asexual or *Chantransia* stage of *Batrachospermum* can reproduce itself for several generations by sporules, and continues to do so when growing in dark or shaded situations, while the sexual or *Batrachospermum* stage is mostly produced when growing in the light. On this account it is difficult to demonstrate the genetic connection between the two stages, which, however, has been done by Sirodot * in several species, and he considers it as a true example of alternation of generations. This of course depends on the author's definition of that term; it is certainly not in any sense an example of alternation of generations as defined by Sachs,† where during the entire course of development, the plant starts twice from a single cell; the first or sexual stage from the germination of a spore, the second asexual stage from the oospore. In *Batrachospermum*, the sexual stage is developed last, and not from a single cell produced by the *Chantransia*, but as a direct vegetative continuation of the latter. It illustrates what Sachs terms "alternation of axes." ‡ The oospore produced by the *Batrachospermum* stage, never reproduces itself directly, but on germination, gives origin to a minute cushion of polyhedral cells, which Sirodot terms the prothallus, and without developing further, can reproduce itself by sporules. Sooner or later it generally gives origin to branched filaments which develope into the *Chantransia* condition, this in turn can produce itself by sporules; if vegetative development proceeds further, the sexual or *Batrachospermum* stage results.

A well-developed apical cell is always present in *Florideæ*, which in the simpler forms is large, cylindrical, and with a rounded anterior end. This mother-cell is divided into two daughter-cells by a straight or slightly curved septum, transverse to the axis of growth, the apical portion growing until it equals its mother-cell in size, when division again takes place in the same manner. When the thallus consists of a single row of superposed cells, the segment, or posterior daughter-cell is at first disc-shaped, the two

* "Les Batrachospermes, organisation, fonctions, développement, classification," Bull. Soc. Bot. France, xxxi. (1884).

† 'Text-Book of Botany,' second English ed., 1882, p. 228.

‡ Tom. cit., p. 228.

principal walls being flat and parallel to each other, and the outer wall cylindrical.

In the more highly developed forms, the apical cell is smaller than in the simpler species, the usual shape, as seen from above, being that of a transverse section of a bi-convex lens; sometimes the two faces are equally curved, as in *Rhodymenia laciniata*; generally the anterior wall is more convex than the posterior. The segment is watchglass-shaped with the concave wall next the base of the apical cell; this segment by subdivision gives origin to the mass of cells forming the thallus. The mode of segmentation characteristic of vascular cryptogams, in which several daughter-cells of equal value are simultaneously cut off from the apical cell, does not occur in this group, although when growth is very active the segment is so soon cut up, that its components present the appearance of having been directly cut off from the apical cell; but later in the season, when cell-development is somewhat retarded, the segment can be seen intact. In all cases when the thallus is composed of more than single rows of cells, the segment first divides into an axial cell, surrounded by a varying number of pericentral cells; these last, owing to the watchglass shape of the segment, stand at a higher level than the apical cell, which thus becomes buried in the surrounding tissue, consequently the organic apex or growing point is much below the geometric apex of the thallus. The species of *Chondriopsis* and *Laurencia* illustrate this mode of growth, which also occurs in some monosiphonous genera as *Batrachospermum* and *Halurus*, where the last whorl of branches, which are lateral extensions of the segment, arch over the apical cell. *Callithamnion roseum* and *C. polyspermum* present the peculiarity of having two distinct methods of segmentation of the apical cell, which in the main axis is cut into two daughter-cells by a septum inclined at an angle of 45° to the axis of growth; the septa are all in the same plane, but slope alternately to right and left, so that the cells just below the growing point are more or less triangular in shape, and the septa form a zigzag line; as the cells increase in size, the triangular form is lost, and at some distance behind the apex they are cylindrical and the septa transverse. In all the branches the segments are cut off by septa, which are from the first at right angles to the axis of growth.

Branches originate either by lateral budding or by division of the apical cell. The first method is most general, the branches showing as minute protuberances from the segment, as in *Ptilota elegans* and *Cystoclonium purpurascens*, or more frequently from a cell further back, as in *Ahnfeldtia plicata* and *Plocamium coccineum*. All species with a flattened thallus appear to branch by this method. According to Sachs* the lateral branches show as promi-

* 'Text-Book of Botany,' second English ed., 1882, p. 140, fig. 108.

nences on the apical cell in *Stypocaulon scoparium*. Division of the apical cell occurs in some highly differentiated genera as *Ceramium*, *Pandorea*, and *Dasya*. Branches always originate directly from axial cells, and even when the axis is polysiphonous and densely corticated, their organic connection with axial cells can be demonstrated. Sometimes, as in *Dasya coccinea*, adventitious branches are present which originate from cortical cells. These present the appearance of hairs and consist of a single row of cells. When an apical cell is about to divide to form two branches, immediately after a daughter-cell has been cut off, and while the apical cell is still small, it is divided into two equal portions by the appearance of a septum in the direction of the axis of growth of the branch. If the branches are all developed in one plane, this septum is at right angles to the plane of the branches; but when they are arranged in a spiral, the septum is at right angles to the plane of the branch immediately below. After the formation of the vertical septum in the apical cell, the two daughter-cells commence growth, but there is no connection between the origin of branches and their ultimate arrangement. If the two cells develope at the same rate, and diverge at equal angles from the direction of the podium from which they originate, a dichotomy is the result, as may be seen in *Pandorea traversii*, and sometimes in *Dasya coccinea*. If one cell grows more vigorously than the other, and in the same direction as the podium, the other growing at an angle, and resembling a lateral branch, a sympodial arrangement results, as is usual in *Dasya coccinea*. When branches originate as lateral protuberances the ultimate arrangement may be dichotomous, as in *Callithamnion corymbosum;* sympodial, in *C. tetragonum;* or monopodial in *C. polyspermum*, depending on the relative development and direction taken by the branch and the axis from which it springs. In the filamentous members of the *Florideæ*, in which the axial cells remain, "protoplasmic continuity," which is so conspicuously developed in the group, enables an observer to determine with certainty the mode of origin of any branch, even when fully developed, depending on the number and arrangement of the threads of protoplasm connecting the protoplasts of adjoining cells. When the branch originates as a lateral protuberance, the curved septum that cuts it off from the parent cell is pierced by one protoplasmic thread, which connects the protoplasm of the one-celled branch with that of its mother-cell. This one-celled branch is an apical cell, from which in due course is cut off a segment. This segment constitutes the basal cell of the new branch, and is never connected by protoplasmic threads with more than *two* cells, the one from which it was segmented below, and the one cut off from it above. When branches originate from the division of an apical cell, the two sister cells resulting from the formation of a vertical

septum in the apical cell, are connected laterally by a protoplasmic thread passing through the vertical septum. Each is the apical cell of a new branch, which eventually, owing to the appearance of a transverse septum, is cut up into a segment and an apical cell. Each segment forms the basal cell of a new branch, and is joined to *three* other cells by protoplasmic threads; to its sister basal cell, laterally; to the cell below, from which it was segmented, and to the cell above, which is the second cell of the new branch.

The wall in young cells consists at first of pure cellulose, and remains as such until, owing to surface growth, the cell has increased considerably in size. Surface growth is rarely uniform over all points of a cell-wall, and as a rule is much more vigorous in the direction of the axis of growth than transverse, so that a cell originally presenting the appearance of a disc much broader than long, becomes not unfrequently ten, or even twenty times as long as broad. When pericentral cells are cut off from an axial cell by vertical septa, they grow most in the same direction as the latter, and usually at the same rate, thus giving origin to a stem composed of fascicles of superposed cells of equal length, as in the genus *Polysiphonia;* but when branches spring from an axis their component cells increase most in the direction taken by the new growing point, which may be at right angles to that of the parent stem. Cortical cells, or those developed for the purpose of adding to the substance of the axis, differ in origin from branches which form new axes. The latter appear as protuberances before separation from the mother-cell by a septum, while the first indication of cortical cells is the presence of curved septa, cutting off portions of the mother-cell, soon after its segmentation from the apical cell. This mode of cortical cell development can be well studied in the genus *Polysiphonia.*

In some instances the cortication of the stem is due to adpressed branches, as in the genus *Ceramium*, where the stem consists of a single row of superposed cells. From the anterior end of each cell, as in *Batrachospermum*, a whorl of branches originate, which instead of developing in a normal manner, and leaving the stem at an angle, remain adpressed to it, and by cell development cover it more or less completely. In *Batrachospermum* the whorled branches spread more or less at right angles to the stem, but the secondary branch which springs from the basal cell of each of the whorls of branches, grows downwards and is closely adpressed to the stem. These corticating branches continue to grow downwards until they reach the base of the stem or nearly so, where they act as rhizoids, and assist in fixing the plant, so that towards the base the stem of an old plant is densely corticated, whereas near the growing point the adpressed branches may be seen starting from

the basal cells of the branches, and not having yet reached the next whorl of branches below, between which they pass in their downward growth. In some species these corticating branches themselves branch, the ultimate branches developing at right angles to the stem, and presenting the appearance of hairs. In the genus *Crouania*, this mode of cortication is yet more complex. A third, and by far the most universal method of cortication results from branches which spring from axial cells in a scattered or whorled manner, becoming densely corymbose and of equal length, the cells decreasing in size from the base to the tips of the branches. The cells of adjoining branches are agglutinated together, so that a dense continuous pseudo-parenchymatous cortex of small closely-packed cells results, the interior of the thallus consisting of comparatively few large cells. This type of cortication is well shown in the genera *Caulocanthus*, *Halymenia*, and *Gloiosiphonia*.

The growth in diameter of cells is generally uniform when free from pressure and not giving origin to lateral branches, and the transverse section circular, while the zone of growth that adds to the length of the cell may be most vigorous near the posterior end, as in the genus *Ceramium*, where the axial cells when young are thin discs, from the anterior margin of which are cut off the cortical cells, the naked portion below increasing much in length, while no increase in the length of the cell takes place anterior to the origin of the cortical cells. In the genus *Polysiphonia* growth is uniform or nearly so throughout the entire length of the cell, which is also disc-shaped at first, and soon segmented into an axial surrounded by cortical or pericentral cells, the protoplasts being connected by well-defined threads of protoplasm. After having attained their full size the connecting threads are seen to occupy the central portion of the length of the cells, showing an equal rate of growth in length anterior and posterior to what was originally the middle of the length of the cell. The first differentiation observable in the cellulose of external cells is the formation of a cuticle, which in the fully developed plant can be shown to exist as a continuous pellicle investing every part. It resists for a long time the action of acids and alkalies, and when treated with chloriodide of zinc or sulphuric acid and iodine, assumes a brown or yellowish colour. Surface growth, or increase in size of the cell-wall, appears to be due to intussusception, as micro-chemical tests show a uniformity of composition throughout; but the thickening of the cell-wall, so conspicuous in many seaweeds, is clearly due to apposition, the cell-wall when young changing to a bright blue when treated with sulphuric acid and iodine, but as the wall increases in thickness the innermost and last added portion alone shows this reaction, the outer portion becoming brown or reddish, gradually passing into blue as it approaches the inside. *Worms-*

kioldia sanguinea is favourable for this experiment. The cell-wall in young leaf-like portions of the thallus being thin, while the older axial parts have the walls much thickened and exhibiting very clearly lines of stratification and striation. An additional proof in favour of the thickening being due to apposition, is met with in *Ceramium rubrum*, *Polysiphonia fastigiata*, and other species of the same genus, where the axial cell, after a certain amount of surface growth, is cylindrical with flat ends, the diameter of the posterior end being often slightly greater than that of the body of the cell, owing to a slight contraction of the cylindrical outer wall. This contraction leaves a little channel inside the base of the cell, and portions of the protoplasm which occupy this channel are cut off from the rest by the thickening matter subsequently deposited, which does not in all places follow the indenture of the wall. These isolated portions of protoplasm, by subsequent growth, burst through between the pericentral cells and form irregular cortical cells on the surface of the stem. In most seaweeds portions of the thickened cell-walls, more especially in the younger parts, become resolved into mucilage, which in species with a fleshy thallus, cements cells together that were otherwise free from each other, so that a transverse section presents the appearance of compact cellular tissue. It is due to the presence of this mucilage that most algæ adhere so firmly to paper when dried.

In the simpler green seaweeds belonging to Harvey's *Chlorospermeæ*, illustrated by such genera as *Pleurococcus* and *Glœocapsa*, we have probably the prototypes of existing vegetation. In such the mode of reproduction is vegetative, and effected by fission, the entire mass of the individual, after reaching a given stage, breaking up into a definite number of pieces, frequently four, each capable of assimilating food until it reaches the size of its parent, when fission is repeated. This mode of reproduction is also characteristic of the lowest forms of animal life. It is interesting to note, that in those organisms where reproduction is effected by fission, there is no provision for death, as generally understood. A *Pleurococcus* after having performed all the chemical and physical functions necessary for the perfect developement of the species, loses its individuality when fission takes place, but all the material appropriated by life is retained, each succeeding generation reducing the limited supply of available food capable of being converted into its own substance. The false start made by the newly-evolved force life, which would—if this primary idea of vitalizing and retaining in that condition all available material had been adhered to—have resulted in its own extermination on the exhaustion of the already existing supply of food, was corrected, and the continuance of life for an indefinite period secured, so far as depends on the presence of an inexhaustible supply of food, by the evolution of a

second type of reproduction which manifested itself in some of the species of the same primitive family of plants, by which, after a limited period of existence as an individual, the sum total of forces constituting its life became concentrated in a small portion possessing the power of reproducing its like, the greater bulk of the individual dying, becoming reduced to its elements, and soon ready to be used again as food by succeeding generations.

This second form of reproduction rendered possible cross-fertilization, which has proved to be a prime factor in enabling life to evolve from primitive types, through its various phases up to existing forms. Sexual differentiation, and the various contrivances for preventing self-fertilization, and at the same time favouring cross-fertilization, which have been brought so prominently before the public in connection with flowering plants, and popularly believed to be peculiar to the higher forms of life, are to be met with in the various groups of algæ; the structural differences in this matter between algæ and phanerogams being the result of the markedly different conditions under which they respectively exist. Algæ, in common with all cryptogams, depend on water as the motor agent by which the union of the two bodies connected with sexual reproduction is effected; consequently the various structures that enable flowering plants to utilize the wind or insects as agents in transporting the pollen to the stigma are absent from the former.

In algæ, again, we trace the evolution from primitive isolated unicellular forms, as *Eremosphæra*, to the more complicated multicellular types, illustrated by the brown and red seaweeds, showing marked differentiation and division of labour, through the numerous stages of cell-colonies composed of unicellular organisms each retaining its original morphological and physiological characteristics, but mechanically held together by mucus. In the Florideæ, if we except a few minute parasitic forms included by Reinsch* on account of their red colour, all the members are multicellular, but, as described above, consist in the simplest types of threads composed of a single row of cells placed end to end. In addition to the sexual reproductive organs, a very characteristic and more universal vegetative method occurs, consisting of the contents of certain cells breaking up when mature into four portions, hence known as tetraspores or tetragonidia. It is remarkable that the exact method of reproduction characteristic of the lowest forms of plant life should reappear in this highly developed family and its near relation *Dictyoteæ*, after having been superseded in the higher green and in all the brown seaweeds. Tetrasporic individuals are, with very rare exceptions, distinct from those bearing sexual organs.

* Reinsch, tom. cit.

Farlow and Bornet mention a few species in which individuals have been met having both kinds on the same individual, and we once found a single plant of *Polysiphonia byssoides* bearing well-developed tetraspores and cystocarps. Some algologists in describing the species included under *Palmellaceæ* and other primitive families, use the term "multiplication" to denote what we have termed vegetative reproduction, and "propagation" when reproduction is effected by specialized portions, sexual or otherwise, hence we presume the terms would be equally applicable to define the two methods of reproduction met with in the Florideæ.

In a carpological arrangement Florideæ stand at the head of the algal family although the vegetative parts, as a rule, are less developed than in the brown seaweeds belonging to *Fucaceæ* and *Laminarieæ*.

The following are the most marked types of thallus development met with in *Florideæ*.

1. When the substance and outline depend entirely on the development of branches of definite growth, springing in a whorled or scattered manner from axial cells; these branches are of equal length and densely corymbose at the tips, which are cemented together, forming a false parenchymatous tissue towards the surface of the thallus, the interior remaining spongy. If the branches all develope equally a cylindrical thallus results, but if growth is unequal and most pronounced in one plane, a flat thallus is produced. The flattened thallus is always evolved from a cylindrical type, in other words the mode of branch arrangement observable in a flat thallus can always be met with in a less differentiated manner in the cylindrical stage, and connecting the two there is every transition.

The following genera illustrate the sequence of development of this type:—

Batrachospermum, branches in whorls, equally developed, whorls distant.

Crouania (*schousbœi* Thur.), branches in approximate whorls, but not agglutinated together.

Calosiphonia (*finisterræ* Crouan), whorls equally developed and approximate, the external cells agglutinated together and forming a continuous cylindrical thallus. In the above example the branches spring from a single row of axial cells; in

Solieria (*chordalis* J. Ag.) the thallus is cylindrical as in *Calosiphonia*, but instead of a single axial row of cells there are several rows, from which the branches spring.

Polycœlia shows the transition from a cylindrical to a flattened thallus. The branches originate from a single axial row of cells; but the lateral branches grow much longer than the anterio-posterior ones, producing a thallus with a more or less compressed

or elliptical outline in section, whereas in *Halymenia* and numerous other genera, the thallus is broad and membranaceous, owing to excessive development of the lateral branches.

2. In the second type the substance of the thallus does not depend on the presence of branches, but on a definite number of pericentral cells or siphons, which are cut off from the axial cells by curved tangential septa. These grow at the same rate as the axial cells, so that the thallus consists of fascicles of superposed cells of equal length. In some species a second set of irregular corticating cells are present outside, and alternate with the siphons, consisting of adpressed branches, originating at the nodes; sometimes in *Polysiphonia*, from portions of protoplasm imprisoned by the apposition of cellulose, during the thickening of the cell-wall, as described above. The following genera illustrate this mode of thallus formation: *Polysiphonia, Bostrychia, Dasya.* When flattened, as in *Odonthalia*, the fascicled arrangement is masked, owing to subsequent growth, but the typical polysiphonous structure is clearly seen in the younger portions.

3. In a third type the thallus is typically flat and membranaceous, resulting from the branches of a filamentous thallus, as in *Callithamnion*, being connected by a web or membrane of tissue. In some species the connecting membrane is only one cell thick, in others it is composed of several layers of cells, owing to subsequent cell-division parallel to the surface. In most species the evidence of their filamentous origin can still be traced in the so-called "veins" in the membranaceous thallus, and microscopic examination clearly shows that these veins give origin to the cells which, by division, form the flattened portion. The arrangement of the veins may be dichotomous and develope into a flabellate or irregularly expanded thallus, as in *Nitophyllum* and *Callophyllis;* or pinnate, as in *Delesseria*, where the British species furnish a most interesting sequence from the filamentous *D. angustissima* to *D.* (*Wormskioldia*) *sanguinea*, where each portion of the thallus, under favourable conditions, resembles an obovate or oblong leaf, from four to seven inches long, with a strong midrib, giving off secondary and tertiary veins corresponding to the cell traces. A further proof of the statement as to the evolution of the membranaceous genera mentioned, as well as others, from filamentous ancestors, is the fact well known to algologists, that the form and expansion of the thallus in this type is one of the most untrustworthy of characters; a well-selected series of most species illustrating a transition from filamentous to broadly expanded forms; and further, it is by no means unusual to meet with the various transitions on the same thallus, as shown in Harvey's figure of *Halymenia ligulata* Ag.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Spermatogenesis in Mammals.‡—Herr C. Benda, continuing his account § of mammalian spermatogenesis (which is in essential agreement with that lately given by Mr. H. H. Brown),‖ discusses the existence of an internal process from the "supporting cell." The presence of a single process he regards as the artificial result of reagents, but affirms the existence of a brush-like bundle of fine filaments with which the young sperms become connected. He describes the elongation and subsequent retraction of the supporting cell, and shows how in consequence of the latter, which is unusually marked in the rat, the sperms come to be displaced even to the extent of reaching the wall of the canal.

The pointed pole of the young sperm represents the position first connected with the supporting cell, and towards this pole the nucleus moves, exhibiting a chromatin body which points in the same direction. The behaviour of this apical knob in uniting with the process of the supporting cell, and the further modifications of the sperm-cells are briefly described.

Blastodermic Vesicle in Mammals.¶—After giving a brief *résumé* of Van Beneden's account of the segmentation of the rabbit's ovum, and referring to the theories of various writers as to the meaning and

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with processes of Evolution, Development, and Reproduction, and with allied subjects.

‡ Arch. f. Anat. u. Physiol. (Physiol. Abth.), 1886, pp. 386–8.

§ Cf. this Journal, *ante*, p. 209.

‖ Cf. this Journal, v. (1885) p. 783.

¶ Scientif. Proc. R. Dublin Soc., iv. (1885) pp. 536–45 (7 figs.).

use of the "outer layer" of the segmented ovum, Prof. A. C. Haddon suggests an explanation of these facts.

The "outer layer" corresponds to the non-embryonic epiblast of the area opaca: the middle layer of the blastoderm is the embryonic epiblast, and the deep, flat cells, form the hypoblast. The "blastopore" of Van Beneden indicates in an exaggerated manner the separation between the embryonic and non-embryonic germinal layers, since the blastoderm has sunk into the blastodermic vesicle owing to the absence of yolk.

The author gives a series of woodcuts of hypothetical mammalian eggs, in which is shown the manner in which the true embryonic epiblast (which lies at first, as in fowl's egg, on the surface of the yolk) sinks into the yolkless vesicle; the non-embryonic epiblast, which has now extended round the blastodermic vesicle, owing to the loss of yolk, gradually grows over the in-sunk embryonic epiblast: the stage before the meeting of the sides of the embryonic epiblast being represented by the stage in the actual mammalian egg when Van Beneden's "blastopore" is present. The cells of the embryonic epiblast now arrange themselves in a definite layer below the non-embryonic epiblast or covering cells, and below it again is the hypoblast, as in the actual mammalian blastodermic vesicle. The segmentation of the mammal's ovum is very abbreviated; the first cleavage furrow demarcates the embryo from the yolk-sac.

The author then refers to the researches of Agassiz and Whitman and others as to the orientation of the primitive segmentation spheres.

In the marsupials it has been shown that the subzonal membrane of the yolk-sac serves to attach the embryo to the wall of the uterus, either by vascular villi or by simple amœboid processes of the cells: so in the rabbit the covering cells, or non-embryonic epiblast of the blastodermic vesicle (i. e. yolk-sac) "form the first adhesion between the ovum and the parent."

This temporary adhesion in the Eutheria is later on replaced by allantoic villi.

Horny Investments of the Eggs of Scyllium stellare.*—Herr C. F. W. Krukenberg gives a full account of his experiments on the egg-shells of *Scyllium stellare*, and points out that in some the substance resembles cow's-horn and human hair.

β. Histology.†

Phenomena of the Division of the Cell-nucleus.‡—M. L. Guignard directs attention to some of the phenomena which accompany the division of the nucleus of the cell, with especial reference to the recent theories of M. Degagny. That botanist teaches that the nuclei disappear progressively as the equatorial zone becomes colourable. This is denied by M. Guignard, who points out that the coloration of the equatorial zone is due not to nuclei but rather to the cyto-

* MT. Zool. Stat. Neapel, vi. (1885) pp. 286–96.
† This section is limited to papers relating to Cells and Fibres.
‡ Comptes Rendus, cii. (1886) pp. 1036–8.

plasmic granulations which play an important part in the formation of the cellular plate, and of which M. Degagny makes no mention. The figured element must not be confounded with the amorphous nuclear fluid; methylene-blue is not a suitable substance for differentiating the elements which enter into the constitution of the nucleus or of the cell.

New Element in the Blood.*—After giving his own observations on the "new element" of the blood, for which he adopts the name *plaque*, Mr. G. T. Kemp gives an historical review of the literature on the subject, and the theories as to the origin and function of these *plaques*. He describes their histology and micro-chemistry, and concludes with a bibliography of the subject.

The results of his own and other observations he summarizes in the following words:—

1. In addition to the red corpuscles and leucocytes, the blood normally contains a third histological element, the plaques.

2. Although strong resemblances exist between the plaques and the other histological elements of the blood, there is not yet sufficient evidence to establish a genetic connection. We are therefore obliged, for the present at least, to regard the plaques as independent elements.

3. When the blood is drawn the plaques break down almost immediately. This is not true of any other element in the blood.

4. The breaking down of the plaques is intimately connected, in its time-relations at least, with the clotting of the blood.

5. The connection between the breaking down of the plaques and the coagulation of the blood is not histological, but chemical, i. e. the plaques appear to give a soluble substance which is active in coagulation.

6. The active agent in question is most probably *fibrin-ferment*.

7. Fibrin is deposited histologically independent of any of the cellular elements of the blood.

8. When the clot is very scant, fibrin is deposited as long, needle-shaped, crystal-like bodies.

Histology of Central Nervous System.†—Prof. H. Gierke communicates the first portion of a research on the histology of the central nervous system, which consists of a detailed account of the supporting substance ("Stützsubstanz") in which the nervous elements are embraced. His results are based on a study of numerous types from fishes upwards to man.

I. Technical Methods.—(*a*) For the indispensable isolation process Dr. Gierke recommends extremely dilute chromic acid and salts, Ranvier's "alcohol à tiers," but especially a solution discovered by Landois, consisting of (1) neutral chromate of ammonia, 5 gr.; (2) phosphate of potassium, 5 gr.; (3) sulphate of soda, 5 gr.; (4) distilled water, 100 gr. (*b*) For staining, he found carmine by far the most effective colouring substance, in the common associations with

* Stud. Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 294–339 (1 pl.).
† Arch. f. Mikr. Anat., xxv. (1885) pp. 441–554 (2 pls.).

ammonia, or with alum, or with a sodic base. He also recommends strongly Heidenhain's hæmatoxylin. (*c*) Hardening was best effected by a solution of 1½–2½ per cent. double chromate of ammonia. (*d*) Imbedding cannot be in any way satisfactorily accomplished by paraffin, wax, or gum, but the celloidin method recommended by Schiefferdecker was found most effective. (*e*) Dr. Gierke insists especially on the necessity of having fresh material and thin sections, and attributes many discrepancies of result to the absence of these essential conditions. After noting briefly some of the current descriptions of the histology of the central nervous system, and emphasizing especially the incorrectness of the phrase connective tissue, so often applied to the supporting substance, he selects as most convenient Virchow's term, "neuroglia," including in that both the amorphous ground-substance and the definite cellular elements, which together form the matrix in which the nervous elements are imbedded. These two parts make up the whole neuroglia; he denies the existence of elastic fibres, connective-tissue fibrils, free nuclei, &c. The only structures which occur are lymphoid cells which have wandered in, or embryonic cells which have persisted unmodified.

The matrix.—The ground-substance or amorphous matrix forms along with the imbedded cellular elements (1) the outer and inner enveloping mass of the central nervous system, (2) the matrix of the grey substance, and (3) the stronger strands penetrating the white substance. In the grey matter the ground-substance is abundant, varying in different mammals in quantitative development apparently in inverse proportion to the development of the nervous elements, i. e. becoming less as the intelligence increases. It is uniform throughout, homogeneous, structureless, transparent—a soft but firm, not fluid, elastic albuminoid substance. The alleged existence of imbedded molecules, on which so much stress has been laid by some, e. g. Rindfleisch, rests on a misinterpretation of cross sections of fibres, fibrils, and glia-cell processes; the granular character of the ground-substance described by even such accurate observers as Henle, has a similar explanation—the granules belong to the glia-cells.

Cellular elements of the neuroglia.—The neuroglia-cells, often called spider-cells, form the greater part of the neuroglia, extending through every portion of the matrix and forming with their long uniting processes a supporting meshwork. They vary extremely in size, form, nature of processes, and even in consistence, but exhibit relatively constant characters in definite localities.

Processes.—There are no glia-cells without processes, and though cells with only one do rarely occur, there are usually many from each cell. In the white substance the individual processes sometimes interlace before breaking up into extremely fine branches. The marvellous network of processes is even narrower and finer in the grey substance.

Form and size of the cells.—The cells have of course no outer envelope of any kind. The differences in size are extreme, varying with the size of the nucleus, the development of processes, and the degree of horny modification. Two prominent types, connected

indissolubly by intermediate forms, are distinguishable:—(1) cells in which the nucleus is relatively very large and often indeed apparently naked, at least always forming the chief part of the cell; from the nucleus itself or from the little protoplasm round it, a few processes arise, which are always extremely delicate and branching; these cells are most abundant in the grey matter. (2) cells in which the nucleus is either absent, stunted, or ill-defined, but with well-developed, and in adults well-cornified cell-bodies, with firm and numerous processes. The differences between these two forms are described in great detail.

Cornification.—Neurokeratin was described by Ewald and Kühne in 1877; Gierke has shown the exact mode of its origin from the gradual cornification of the cells and their processes. In its study use was made of the digestive method (with pepsin and trypsin), whose application is due to the above-named investigators. While the keratin-forming process advances the nucleus degenerates, gets smaller and crumpled, and finally disappears in the cell. The further this degeneration of the nucleus has advanced, the greater the resistance of the cell to acids and alkalies. In the second form of cell, where the nucleus predominates, the keratin-modification is confined to the processes; neither the nucleus nor the small cell-body are cornified.

Development.—In the embryonic nerve-strand the cells are of course alike, nor after the nerve-fibres are differentiated are there any observable differences in the roundish polygonal "Stützzellen," and even when the glia-cells have developed their characteristic processes they are for a while quite homogeneous. Glia-cells and nerve-cells have emphatically an identical ectodermic origin; the former certainly do not come in from outside with the blood-vessels or in any other way. Gierke protests emphatically, as we have noted, against the common use of the phrase "connective tissue of the central nervous system." The neuroglia is entirely ectodermic, connective tissue is mesodermic, and the histological structure of the two is very different.

He describes in greater detail the history of the "epithelial glia-cells" which limit the glia round the central cavities of the brain and spinal cord, noting especially the latter. At first several layers of long elliptical or spindle-shaped cells are seen regularly arranged round the central canal. The peripheral ends of these cells are narrowed and prolonged in a process in the direction of the longitudinal axis of the cell, and can be followed through the grey and white matter to the margin of the cord. The outer cells of these layers become much modified from without inwards; from them originate both ganglion-cells and multipolar neuroglia-cells; a single layer is at length left—the epithelium of the central canal. Processes from the lateral "epithelial cells" join the fibres of the glia meshwork of the *substantiva gelatinosa centralis*, or penetrating through this unite with the fibres in the grey substance. The epithelial cells before and behind the canal send sagittal processes anteriorly and posteriorly between the symmetrical halves of the cord, uniting with the connective-tissue sheath. Independent fibrils may arise by losing

their connection with cells from which they arose as processes. Such processes from the epithelial cells come to form somewhat irregular bundles between the anterior and posterior horns and in the longitudinal fissures. They run often into the pia and unite with it, while from the pia connective-tissue fibrils, usually in association with blood-vessels, run parallel to the former out to the commissural region of the cord. Thus the so-called "pia processes" filling up longitudinal fissures have partly this connective-tissue origin, but are also in part, and usually for the most part, cornified glia-fibres, either direct processes of the nearest "epithelial cells" of the central canal, or fibres which have become independent. As to the amorphous element, the structureless ground-substance or matrix, Dr. Gierke is inclined to refer its origin to the gradual change of the embryonic cells, though he does not exclude the possibility of its being in part excreted by the glia-cells. In the great subsequent growth of grey matter round about the epithelium and *substantiva gelatinosa centralis*, glia-cells are seen, originating either from those of the inner layer, or more probably from a new modification of embryonic cells. The details as to the modifications of the glia-cells, the development of processes, &c., cannot be summarized.

In the brain the elements of the neuroglia are essentially similar to those of the spinal cord; the two types of cells are not, however, so well marked; the cell-bodies, especially in the molecular layers of the cerebellum, sometimes almost disappear, so that their former position is only indicated by a small knot from which the processes diverge; while the glia-cells in the grey sheath of the cerebrum exhibit as a result of cornification a peculiar nuclear modification, as the nuclei, instead of shrivelling smaller and smaller, retain their size but lose their sharp contour; these cells are further peculiar in their very granular appearance.

Function.—The function of the glia is to surround and protect the nervous elements; it penetrates every portion of the central nervous system; the whole network of glia-cells is continuous, the ground-substance and the nervous elements fill up the meshes. Specially differentiated is the glia-sheath which surrounds the whole central organ and separates the inner substance from the pia mater. It is always to be found where the pia covers the surface; it effects on the one hand the peculiar union between the surface of the nervous organ and the pia, and forms the constant narrow lymph spaces between them, while it is also obviously protective and serves as a sort of basis for the neuroglia network. Its variations and exact histological relations are intimately described, especially as they occur in the pike.

The cavities of the central nervous organ are surrounded by layers of neuroglia in which few nervous elements occur; the "granular tissue" often described is produced by cross sections of processes. Round the cavity of the ventricle this tissue is limited by a layer of epithelial-like cells, sometimes finely ciliated, sometimes flattened. They are in close union with the neuroglia and are modified glia-cells. Besides the outer glia-sheath and the inner lining of the central cavities, the glia framework, with its associated network, is described

in its variations in grey and white substance, and in different regions of these. The firmness of the glia-cells seems to vary inversely with that of the nerve-cells. *Inter alia* Prof. Gierke notes that the nerve-fibres are everywhere enveloped in an ensheathing neuroglia network, whose knots represent glia-cells, and the threads processes. The main threads are bound together by glia-fibres, and the resulting network nerve-fibre sheath is of extreme fineness. He maintains that the medulla-containing nerve-fibres are never imbedded directly in the matrix, but are always separated from it by the formed elements of the neuroglia. The glia framework of the white substance is formed as usual from cells and matrix, but nerve-fibres sometimes occupy the meshes of the network. The arrangement and varying quantitative development of the elements, their relation to the blood-vessels which accompany the stronger strands, &c., are next discussed.

The quantitative development of the neuroglia in the white substance of the spinal cord is proportionately less in the lower vertebrates than in mammals, but Dr. Gierke is unable yet to formulate any certain law. The memoir ends with a comparison of the development of neuroglia in different regions of the white substance. To this most elaborate research, dealing specially as yet only with the supporting substance, a continuation is promised, which, if as thorough as the above, will go far to justify the author's assurance that the central nervous system "which has been hitherto so divergently described and in its essential nature really so little known, will henceforth be one of the best known tissues of the body."

γ. General.*

Parietal Eye of Hatteria.†—Mr. W. Baldwin Spencer reports a remarkable discovery—the presence of a median parietal, or as it might more justly be called interparietal, eye in *Hatteria punctata*, the curious lizard of New Zealand. The epiphysis cerebri of amphibians and reptiles becomes divided into two parts, the proximal of which remains connected with the brain, while the distal is a bladder-shaped structure. In *Anguis fragilis* this distal part, as Von Graaf finds, loses all connection with the brain, and developes into a structure resembling a highly organized invertebrate eye; no nerve, however, is connected with it. In *Hatteria* the similar eye-like organ is provided with a well-marked nerve. The eye is enclosed in a capsule of connective tissue; anteriorly there is a lens which forms the anterior boundary of a vesicle, the walls of which are formed from within outwards of the following layers:—(1) a not well-marked layer, (2) a layer of rods imbedded in dark-brown pigment, (3) a double or triple row of nuclei, (4) a clear layer which may be called the molecular, and (5) a layer of nuclei two or three rows deep. The nerve which enters the eye posteriorly spreads its fibres round the vesicle. A blood-vessel ramifies in the surrounding connective tissue. The eye lies exactly in the median line, and the nerve is single; the latter appears to represent the stalk connecting the distal with the proximal outgrowth from the thalamencephalon. The eye does not reach the surface, but

* This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

† Nature, xxxiv. (1886) pp. 33-5 (2 figs.).

is imbedded in connective tissue, so deeply indeed as almost to preclude the idea of its being affected by light. In a postscript Mr. Spencer adds that he has since found the eye in *Iguana*, *Chameleo vulgaris*, and *Lacerta ocellata*, and has traced the nerve into the proximal part of the epiphysis.

Probable Cause of some Monstrosities.*—Dr. E. Cutler suggests that abnormal forms of spermatozoa are sometimes the cause of teratological conditions in the children, and states that abnormal forms of the following character have been observed in the sperm of man: spermatozoa with two or three bodies, with one body and two or three tails, with two bodies and two tails, and two bodies and three tails. The average proportion of these monstrous spermatozoa is almost 1 in 50,000; their movements are slower, but more vigorous than those of normal forms. In examining the urine for abnormal spermatozoa, it is advisable to make use of a cell 2½ by 3/4 by 1/16 inch, and a dry 1/4 inch objective with a long working distance.

Origin of the Deep-sea Fauna in the Sub-alpine Lakes.†—Three explanations have been offered of the origin and ancestors of the deep-sea fauna of these lakes: according to Prof. A. Forel only one is of practical value. The theory that this fauna is derived from old deep-sea fauna of the tertiary period is inadmissible, for the glacial epoch would have destroyed that fauna, although, it is true, certain organisms, e. g. *Desoria glacialis*, the ice flea, and *Protococcus nivalis*, flourish in ice; moreover, the existing fauna is of quaternary origin. The surrounding mountains, which stood above the covering of ice, may have supported life, but this would have nothing in common with the deep-lake fauna.

According to the author, this fauna arose partly from *voluntary* and partly from *involuntary migration* from lake to lake. When the glacial period ended, as the ice gradually retreated up the valleys, animals and plants, which had been driven into neighbouring regions, would wander back; but this would only apply to river or land fauna, since deep-lake fauna require special adaptations. The pelagic fauna might arise by small littoral animals being carried by currents to the centre of the lake, and there, by natural selection, their descendants might become transparent and otherwise modified for a pelagic existence.

But the bottoms of lakes are completely separated from one another; and even to rise to the surface would be impossible to most of the animals adapted to a deep-lake existence. According to Forel the only explanation is that this particular fauna is derived from the littoral fauna, since a large number of species is found to be common to both fauna, and some are common to the cave fauna. By a *voluntary* migration it is supposed that littoral animals have wandered from the shore, have become bewildered, and in their efforts to return, got further and further from the shore, and therefore in deeper and deeper water; they thus lose their way, and have to remain where they are; their eyes are of little use to them, since for sight they require a bright light, which is, of course, absent in the depths.

* Medical World, iv. (1886) pp. 18–20.

† N. Denk. Schweizer. Gesell. f. d. Ges. Naturwiss., xxix. (1885) 234 pp. Cf. Naturforscher, xix. (1886) pp. 191–3.

By an *involuntary* migration, animals are carried away by fish, e. g. as eggs, or as fish parasites, &c. Though rare, landslips on the shore may be a means which should be considered.

Ebb tides carry mud from the littoral zone, and with this mud eggs and small animals.

Lastly, animals and eggs fix themselves to pieces of wood, &c., which float away from shore, become waterlogged and sink, and the animals may in this way become naturalized to a deep-sea life. If these small causes, occurring year after year, be considered in the aggregate, voluntary and involuntary migrations will probably be sufficient to explain the origin of this deep-lake fauna.

B. INVERTEBRATA.

Horizontal and Vertical Geographical Distribution of the Pelagic Fauna of Fresh-water Lakes.*—Dr. O. E. Imhof finds that some species of Copepoda, Cladocera, Rotatoria, and Protozoa are ubiquitous, while others are limited to very definite areas. This, which is particularly true of horizontal distribution, applies also to the vertical; *Anuræa longispina* is the most widely distributed vertically, while other species are found only at certain depths.

Endothelium of the Internal Wall of Vessels of Invertebrates.†—M. W. Vignal finds that the vessels of invertebrates have an epithelial layer which presents the same characters as the endothelium of the lymphatics of vertebrates, and that the vessels of invertebrates open into the interstices of the connective fibres, where, as we know, Bichat and Ranvier place the origin of the lymphatics of vertebrates; this mode of origin is, in the author's opinion, more than probable, although it has not been absolutely proved in consequence of the obstacles to injections which are presented by the valves of the lymphatic trunks.

M. Vignal reminds us that Prof. Sabatier has noted the existence of an endothelium on the internal surface of the vessels of the mussel, but he has figured it as resembling a blood endothelium, while the stomata which he figures are, as Afferow has demonstrated, due to imperfect impregnation; nor are they nuclei, as Sabatier supposes.

Blood of Limulus, Callinectes, and a Holothurian.‡—Dr. W. H. Howell thinks that there is no good reason why there should not exist to a certain extent, in closely allied animals having the same general habits of life, a fundamental similarity in the chemical constitution of the blood. An albumen may still be present in the blood of an animal, as a remnant of a previous mode of life, although now no longer useful; and in this way the study of the blood may be a useful indication of the true affinities of the animal. By the study of the coagulation of the blood in the lower animals, since it is probably simpler than in vertebrates, a better understanding of the phenomena in mammalian blood may be obtained.

* Zool. Anzeig., ix. (1886) pp. 335–8.

† Comptes Rendus, cii. (1886) pp. 1027–8.

‡ Stud. Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 267–87 (1 pl.). See also this Journal, *ante*, p. 68.

Limulus is a convenient animal in which to study coagulation, on account of the great quantity of blood contained. On exposure to air it coagulates, though not firmly, in a few minutes. Dr. Howell was unable to prevent coagulation by saturation with magnesium sulphate, which Halliburton found possible. Four different albumens were found, coagulating at 60° C., 70° C., 75° C., and 80° C. The last is especially difficult to precipitate completely. The author differs from Halliburton in regarding the name hæmocyanin as more applicable to this last albumen. From the various experiments on the serum the author concludes that the albumens of *Limulus* serum belong to the globulin group, and though not identical with paraglobulin, it is to it that they approach most nearly. Hæmocyanin, a combination of copper with proteid, gives no absorption bands, though it cuts off a large portion of the blue rays. When oxygen is excluded it loses colour; this is well seen in the blood of Crustacea; but in *Limulus* the result is not so evident; the respiratory process seems less marked. The loss of colour only commences when the last albumen begins to be thrown down. Coagulation is caused by the union of processes sent out by the corpuscles; these processes shorten and draw the corpuscles closer together. The fibrin thus formed resembles that of mammalian blood, by its solubility in 10 per cent. magnesium sulphate.

In *Callinectes* the coagulation of the blood when drawn is much less rapid than in *Limulus;* moreover a firm jelly is formed. There are only two albumens, coagulating at 55° C. and 68° C., the latter of which is hæmocyanin. The blue colour of the blood disappears on the passage of CO_2; and the author considers, from various experiments, that the hæmocyanin in the two animals is a different substance. The albumens appear to be globulins. The coagulation arises in the same general way as in *Limulus*, but the fibrin produced has different properties. Dr. Howell concludes from the examination of the blood in these two animals that "the differences are too wide to permit us to suppose any close relationship between the two forms;" but observations on the blood of arachnids are necessary before concluding anything as to the relation of *Limulus* to them.

In the perivisceral fluid of a Holothurian—*Thyonella*—oval, nucleated, hæmoglobinous corpuscles are found, as well as colourless amœboid corpuscles. These corpuscles sink and form a sort of incipient coagulation, caused by the fusion of thick pseudopodia of the white corpuscles, as well as of the corpuscles themselves; the red corpuscles do not fuse, but may get entrapped in the mass. No albumens were found in this serum.

Mollusca.

Embryology of Gastropods.*—Mr. J. P. MacMurrich gives a preliminary account of his work on the development of some marine Prosobranchs.

Out of the numerous eggs deposited by *Fasciolaria tulipa*, in each

* Johns-Hopkins Univ. Circ., v. (1886) pp. 85-6.

capsule only six or eight develope. In the case of *Purpura floridana* a certain number of ova, after undergoing segmentation, break down and are used as food by the surviving ova. In *Neritina* only one egg, out of a number in each capsule, segments and comes to maturity.

The eggs of *Fulgur carica* are large and contain much yolk: a single large polar body is formed. After dividing into two and then four equal spheres, four protoplasmic micromeres are separated off from the macromeres; then four more micromeres are formed, and they continue to divide. This process of micromere-separation goes on till the macromeres are covered; and even after the blastopore has closed, new micromeres are formed, which give rise to mesoderm: thus this layer is not due entirely to a large primitive "mesoblast" as in *Nassa*. The stomodæum is formed on the area of closure of the blastopore. The development of the endoderm was not satisfactorily made out. The author holds that this method of segmentation is essentially the same as that in Hirudinea, Gephyrea, Turbellaria, &c., and that all have been derived from forms which had a typical segmentation, such as that seen in Pulmonata and many other Gastropods; other forms in each group having departed from their original mode by the subsequent loss or addition of yolk. Thus, the regular segmentation so frequently occurring is not primitive, but has been secondarily induced by absence of yolk.

In Lamellibranchs, Pteropods, and Heteropods, the formation of the supræsophageal ganglion agrees with that in the typical trochosphere larva of *Polygordius*. In marine Prosobranchs, however, these ganglia arise as independent ectodermal thickenings, which become later on united to one another and to the pedal ganglia.

The apical thickening in the trochosphere larva, from which the supræsophageal ganglion is formed, is represented in others by the problematic cells, regarded by Wolfson as a nervous organ; but the ganglion is not, in these forms, formed from these cells. The prosobranch veliger is very highly specialized, and affords an excellent instance of larval specialization, independent of specialization of the adult.

Nervous System and Organization of Scutibranch Gastropoda.* —M. E. L. Bouvier unites under the head of Scutibranch Gastropods a number of molluscs which have been placed with the Cyclobranchiata and the Aspidobranchiata; they are united by the following characters:—

1. The cerebroid commissure is very long, so that the ganglia are set at the sides of the digestive tube; these ganglia are produced forwards and below to form a strong ganglionic projection, which is united with that of the opposite side by a subœsophageal commissure; this cord is called the proboscidial commissure.

2. The stomato-gastric system arises from the inferior point of the proboscidian projection, and forms a loop; the two sympathetic ganglia are generally widely separated.

3. The pedal ganglia are well developed and form pedal cords,

* Comptes Rendus, cii. (1886) pp. 1177–80.

while the principal nerves with which they are continuous are almost always united by transverse commissures.

4. The pallial ganglia are always more or less intimately connected with the pedal ganglia.

The two first of these sets of characters are regarded as being primitive in nature. Some of the facts here brought forward are in opposition to the statements of M. Bela Haller, who denies the presence of the proboscidian commissure described by Lacaze-Duthiers in *Haliotis tuberculata*. M. Bouvier is able to support the statement of the French anatomist on this and other points traversed by M. Haller.

Retina of Helix pomatia.*—In a further communication on the structure of the optic organ, Prof. J. Carrière describes the retina of this common snail. The method of examination employed was to cut off the tip of the tentacle with the eye, to expose it for a few minutes to the vapour of 1 per cent. osmic acid, and colour with picrocarmine. The removal of the pigment was effected by very dilute eau de Javelle, but this is an operation which must be performed with great care. Sections of about 0·005 mm. thickness were made.

The colourless cells were found to be flask-shaped, and to have contents which were not stained either by picrocarmine or by hæmatoxylin, but with osmic acid hardened to a clear grey mass which completely filled the cell, and rose above it as a convex swelling. No differentiation was to be noticed within the mass; when the convex boundary was distinct, the cell was divisible into a retina and hardened lens, but in other cases the cell-contents appeared to pass directly into the lens. The colourless cells are not regularly polygonal but intercalated among the pigmented, so that they present all stages between an irregular polygon and a star; their lateral processes entered as far as the pigmented cells. The pigmented cells are not filled with pigment, a narrow axial cord being free from it; when the pigment is removed the cells are seen, on staining with picrocarmine, to have a homogeneous transparent grey cell-body, which is very different to the reddish-yellow contents of the flask-shaped cells; there is a highly refractive axis which corresponds to the bright spot seen in pigmented cells, from which the colour has not been removed. In some points the author differs from the results recently published by Hilger.

Organization of Phœnicurus.—Dr. R. S. Bergh † has addressed a letter to Prof. H. de Lacaze-Duthiers in which he expresses his opinion that *Phœnicurus* is really a papilla of *Tethys;* he bases this view on what he has himself been able to observe at Naples. The Professor, in an extended essay,‡ adds to our knowledge of this form, on which he has already published a note §; in answer to his critic he points out that no figure has ever been published by him or by those who think with him, and reminds us that Dujardin stated in 1845 that

* Zool. Anzeig., ix. (1886) pp. 220–3.
† Arch. Zool. Expér. et Gén., iv. (1886) pp. 73–6.
‡ Tom. cit., pp. 77–108 (2 pls.). § See this Journal, v. (1885) p. 1005.

several naturalists had confounded the appendages of certain molluscs with the true *Phœnicurus;* as to the hepatic trunk spoken of by Bergh, it is not the dendrocœlous digestive tube of *Phœnicurus* for that has no resemblance to a hepatic appendage; the so-called mouth is really the external circulatory orifice; this question is entered into in great detail. At the end of a number of arguments forcibly put M. de Lacaze-Duthiers pertinently asks what can be the use to the *Tethys* of such large appendages which fall off so easily?

Pericardial Gland of Lamellibranchs and Gastropods.*—Prof. C. Grobben, who has already shown that the so-called branchiocardiac appendage of the Cephalopoda is a glandular structure, now extends his observation to other classes of the Mollusca. In the Lamellibranchiata the pericardial gland has either the form of glandular lobes or of cæca, which are developed from the pericardiac epithelium, and lie in the anterior angle of the pericardiac space. The lobes are found in *Arca*, *Mytilus*, *Pecten*, and *Ostrea;* the lobes in *Unio*, *Venus*, and *Scrobicularia*, but they differ considerably in their grade of development. The epithelial cells which form the gland contain concretions of various forms and sizes. Among Gastropods a similar organ is to be observed in *Fissurella*, *Parmophorus*, *Haliotis*, *Turbo*, and *Trochus*.

The function of the gland appears to be excretory, and to be allied to the renal; the products probably escape into the kidney, whither they are driven by its ciliated infundibula. The glands appear to have a general homology with those already described in Cephalopods; their presence in the last-mentioned group leads the author to believe that the Cephalopoda represent a branch of the molluscan phylum which very early became independent of the rest.

Pedal Gland and Aquiferous Pores in Lamellibranchs.† — Dr. T. Barrois has studied in sixty species the glands of the foot and the aquiferous pores of Lamellibranchs; the differences which obtain in the different families are described, and the conclusion is arrived at that the byssus is peculiar to the group, and is secreted by glands which are homologous with the pedal glands of Gastropods; various stages of degradation are to be seen in various families. The examination of the intercellular canals and aquiferous pores, which are in some forms completely wanting, has shown that the so-called aquiferous pores are really the orifices of the byssogenous glands, and that there is no direct communication between the circulatory apparatus and the exterior; there is, in fact, no mixture of blood and water.

Eyes of Pecten.‡—Referring to Hickson's theory that the "eye" on the mantle of *Pecten* serves to warn the animal of the ebbing tide, by reason of its being affected by the growing intensity of the light, Prof. B. Sharp has reason to think that this "eye" is an organ not for admission but for emission of light; that is, that it is the organ whence the phosphorescence observed in this mollusc is derived.

* Zool. Anzeig., ix. (1886) pp. 369–71.
† Pp. 170, 8 pls. 4to, Lille, 1885. Cf. Journ. de Microgr., x. (1886) pp. 93–5.
‡ Proc. Acad. Nat. Sci. Philad., 1886, pp. 61–2.

Poison of the Edible Mussel.*—Dr. G. Baumert reports that on examination the poison of the mussel was found by Herr E. Salkowski in a cold alcoholic extract of the substance of the mollusc; watery extracts were also poisonous; these results were obtained by physiological experiments. The chemical investigation of Herr Brieger showed that there was a non-poisonous base, the specific mussel-poison, an extremely poisonous substance which produced a copious flow of saliva and diarrhœa, but was not mortal, and a decomposition-product of poisonous properties. The mussel-poison appears to belong to the group of ptomaines, and is therefore a decomposition-product of the flesh of the mussel. Dr. Schneidemühl is of opinion that the liver is the seat of the poison, therein agreeing with Salkowski.

Molluscoida.

α. Tunicata.

Phylogeny of the Tunicata.†—Prof. W. A. Herdman, referring to the views expressed by Dr. Uljanin in his monograph on *Doliolum*, agrees to the suggestion that the Appendiculariidæ gave rise to other Ascidians, but doubts the origin of the Salpidæ and the Doliolidæ from groups of the simple Ascidians; he thinks it unlikely that the Thaliaceæ were ever fixed simple Ascidians. He would regard the simple and compound Ascidians as being derived from a common ancestor resembling the simpler forms of the two groups, in preference to supposing that the compound were derived from the simple; many of the latter show far more differentiation and specialization of certain important organs (e. g. the branchial sac in the Molgulidæ) than is found in any of the compound forms. He protests against Uljanin's view, that the social are derived from the compound and have no close connection with the simple Ascidians; for there is a very close relationship between the Clavelinidæ and the Ascidiidæ, and the "social" group seems to be distinctly intermediate between the least modified form of the two other groups. *Pyrosoma*, it is agreed, is a modified compound Ascidian, but Prof. Herdman thinks it is derived from the Didemnidæ and not from *Distaplia;* this last is not as extraordinary a form as is generally supposed. The compound Ascidians appear to have had a polyphyletic origin.

β. Polyzoa.

Researches on Blastogenesis.‡—M. L. Joliet, in discussing the gemmation of marine ectoproctous Bryozoa, deals particularly with the criticisms on his previous work which have been made by Prof. Haddon and Dr. Vigelius. He comes to the conclusion that there is only a single homogeneous tissue—the apical endocyst—at the vegetative end of a stolon or cell of a gymnolœmatous form; this is neither ectodermal nor endodermal, but is an indifferent tissue. In some species no other tissue than the parietal endocyst, from which the polypide and the sexual are formed, is to be found; in most,

* Zeitschr. f. Naturwiss., lix. (1886) pp. 60–2.
† Nature, xxxiii. (1886) pp. 546–7.
‡ Arch. Zool. Expér. et Gén., iv. (1886) pp. 37–72 (2 pls.).

however, the apical endocyst becomes differentiated into two systems of tissues—the parietal endocyst, which continues to form and thicken and gradually loses its vital structure and activities, and the endosarc, or central endocyst (or funicular tissue, &c.), which takes on a special structure varying with different species, but always preserves its vital activity and remains an indifferent tissue. As soon as the homogeneous tissue which forms the polypide has become differentiated into two layers, there is an ectodermal tissue enclosed in a pouch which is at once endoderm and mesoderm. This tissue undergoes a fresh differentiation, for in its centre a small mass of cells which will form the intestine become isolated. Henceforward the individual bryozoon is constituted, and so far the author agrees with Vigelius, Haddon, and Barrois. Before the appearance of the polypide in the zoœcium the latter has only contained an indifferent tissue; after its appearance all is changed, and a number of organs appear. The tentacles with their flagellate epithelial cells, and the epithelium of the lophophore and of the œsophagus no doubt represent the ectoderm. The tentacular sheath consists internally of muscular fibres, and externally of a layer of delicate flattened cells, which appear to be ectodermal. The parietal endocyst, differentiated and specialized as it is in *Flustra*, may be regarded as forming an outer skin, or somewhat more definite ectoderm. All the parts in the zoœcium, which are contained between the outer skin and the intestinal epithelium with the internal epithelium of the tentacular sheath form the mesoderm and the general cavity.

In a future work the author hopes to show that in Endoprocta and Lophopoda the endocyst and endosarc take on the special characters of an ectoderm and a meso-endoderm; that the archenteron arises in the midst of this latter; that the lophophore, œsophagus, and rectum are directly produced by the ectoderm; and that in all Bryozoa the polypide is constituted and developed along a general uniform and common plan.

Development of Cyclostomatous Marine Bryozoa.*—Herr A. Ostroumoff finds that the larvæ of the Cyclostomata are the most simply organized of the marine Bryozoa; their whole surface is covered with cilia; at one pole there is a sucker, and at the other the mantle-cavity. The endodermal cavity disappears before the larvæ escape; there is no velum, and no other provisional organs are developed. As in other larvæ, metamorphosis commences with the protrusion of the sucker which forms the basal wall of the primary zoœcium, and with the overlying of the basal surface by the mantle. The broadening basal wall gives off a special kind of stolo prolifer, the "lame germinale" of d'Orbigny. The ectodermal rudiment of the polypide is formed from a plate which is delaminated from the ectodermal cells at the point where, in other larvæ, the velum is developed. This plate then bends basalwards and becomes invested by mesodermal cells. The so-called "lame germinale" is homologous with the stolo prolifer of the Vesicularidæ, and the groups Incrustata and Stolonifera connect therefore the two orders, Cyclostomata and Ctenostomata.

* Zool. Anzeig., ix. (1886) pp. 283–4.

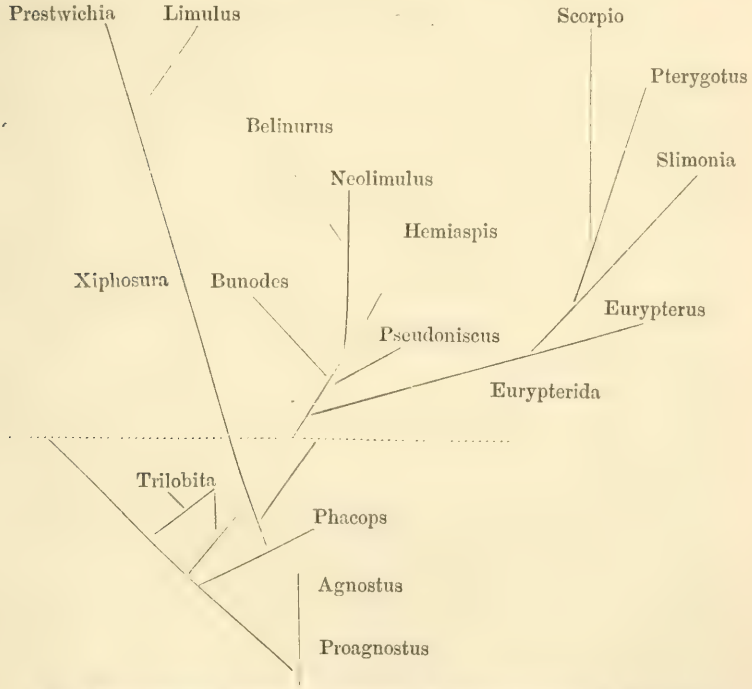
Arthropoda.

Affinities, Origin, and Classification of Arthropoda.*—Dr. A. C. Oudemans is of opinion that the group Arthropoda ought to be given up; in support of this proposal he discusses seriatim a number of the sub-groups of which the larger group is at present supposed to consist.

1. The Acaroidea appear to be a special group, which ought to be separated from the Arachnoidea.

2. The Tardigrada appear to be more closely allied to the Chætopoda than to either the Arachnoidea or Acaroidea.

3. The relations of the Scorpions, Trilobites and King-Crabs, may be indicated by the subjoined table:—



4. The Crustacea, after the removal of heterogeneous forms, are a natural group, whose primitive larva is the *Nauplius*, which is very different to the primitive larva of the Arachnoidea—*Proagnostus*.

5. Dohrn has completely proved the absolutely separate position of the Pantopoda.

6. The Onychora (*Peripatus*) are also very distinct; their development shows that they come from animals like the Gastrula with a

* Tijdschrift Nederl. Dierk. Vereen., i. (1886) pp. 37–56.

nerve-ring round the blastopore; it is quite possible that this branch is much younger than that of insects.

7. Embryology does not yet enable us to say definitely whether the Hexapoda and Myriopoda form a natural group, but the evidence of anatomy is in favour of their being so; the difficulties presented by the Chilognatha are not yet solved. The Hexapoda must have branched off early from the common stem. At present the two sets may be kept together under the name of Insecta; as for the rest, they are best compared *à posteriori*, and not *à priori*.

Embryology of Insects and Arachnids.*—The embryology of Arachnids shows many resemblances to that of insects. Mr. A. T. Bruce has traced the development of *Thyridopteryx ephemeræformis* from early segmentation to an advanced embryonic stage. In the earliest stages cells are found in the yolk, whence they emigrate to form a blastoderm; the egg therefore is not truly centrolecithal. Some of these cells never reach the surface, but remain as "yolk bulbs."

In the grasshopper all the cells emigrate, and the yolk is arranged in pyramidal masses.

The embryo in insects is formed from a thickening of the surface of the egg, like the primitive annulus of spiders.

The endoderm and mesoderm arise partly by invagination and partly by delamination along the middle line; the yolk-cells appear to have nothing to do with the formation of endoderm. No "dorsal organ" like that described by Brandt in the Neuroptera, was observed in the insects studied—including Lepidoptera, Coleoptera, and Orthoptera.

The nervous system arises as two ectodermic strings at the sides of the blastopore.

The supra-œsophageal ganglion in *Thyridopteryx* consists of two parts, the posterior of which supplies the paired labrum, the anterior, the antennæ.

In the grasshopper both maxillæ have two lobes at the base of the main axis, recalling the exopodite and epipodite of crustacean appendages, though they are probably not homologous.

In one stage of the spider embryo an abdominal appendage is being converted by invagination into a lung-book.

The amnion in *Thyridopteryx* forms part of the dorsal surface of the body.

Tracheal invaginations occur in the maxillary segments of the grasshopper.

a. Insecta.

Spermatogenesis.†—Continuing his classical researches on spermatogenesis, Prof. v. la Valette St. George describes the development of the sperms in *Blatta germanica*. The male glands, which have the form of four transparent vesicles lying in the last segment, and provided with a fine efferent duct, are surrounded by white fatty

* Johns-Hopkins Univ. Circ., v. (1886) p. 85.

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 1–12 (2 pls.).

bodies, by a structureless tunica adventiva, and by a nucleated tunica propria, which with its internal prolongations divides the gland into spherical segments. The spermatocysts within, surrounded by a nucleated envelope, contain the spermatocytes, and resulting spermatides. The investigation of the development of the spermatocytes, preserved in an indifferent fluid, was best achieved by staining with dahlia. The nucleolus both in spermatocyte and spermatide is described as a thickened inward projection of the nuclear membrane. The nuclear metamorphosis of the probably three successive generations of spermatocytes is described in some detail, and in essential agreement with the accounts of similar processes given by Bütschli and Mayzel. The origin of the accessory nuclear body from the cytomicrosomata in the spermatocytes, and of these from remnants of the spindle-fibres is described. As in his previous communications, v. la Valette St. George refers the transitory head of the sperm to the nucleus of the spermatide, the tail to the protoplasm, and the middle portion to the accessory body or "Nebenkern."

Germinal Layers in Hydrophilus.*—Dr. K. Heider has communicated some of the results of his studies on the development of *Hydrophilus* in an account of the formation of the germinal layers.

After describing the general characters of the ovum, he notes (*a*) the appearance, multiplication, and migration outwards of the cellular corpuscles which form the future cells of the blastoderm. These reach the superficial plasma layer, first at the posterior pole, where they become defined into cubical-rounded cells. (*b*) The next change is the formation of the ventral plate as a somewhat thicker, slightly arched layer, which becomes marked off by longitudinal furrows and slightly projecting lateral walls, to form the endoderm and mesoderm plate described by Kowalevsky. The furrows becoming deeper, unite anteriorly and independently posteriorly, and the whole plate is somewhat sunk below the level of the ectoderm. (*c*) This is followed by the insinking of the plate, and its curvature into a median canal which becomes grown over by the ectodermic margins. The margins of the furrow-like invagination represent the blastopore, and it is interesting to note that the very anterior portion is the last to be closed, persisting as a distinct aperture in the future position of the œsophageal invagination which occurs at a much later stage. The future closure of this region, and the details of the general invagination, the subsequent broadening and flattening of the tube, as if by dorso-ventral compression, and the appearance of the lumen at various stages till its final disappearance, are then described in detail.

When (*d*) the furrow has been completely closed, and when the embryonic envelopes have completely arched over the embryo, Kowalevsky's second period of development begins,—the period of the differentiation of endoderm and mesoderm, and of the appearance of the organs. On the ectoderm, on both sides of the middle line, the first hint of the nervous system is seen as a slight thickening. The compressed tube, with its all but wholly obliterated lumen,

* Abh. K. Preuss. Akad. Wiss. Berlin, 1885, pp. 1–47 (2 pls.).

becomes differentiated into a two-layered endo-mesoderm. The boundary between the external layer next the ectoderm and the internal layer next the yolk represents the compressed lumen of the primitive tube, i. e. the primitive enteric cavity of the modified gastrulation. The histological differentiation of the two layers is discussed in detail, and Dr. Heider shows how from the external, the somatic mesoderm arises, and from the inner, the endoderm and muscular lining of the alimentary canal. (*e*) The boundary between the outer and inner layer enlarges on either side to form clefts which increase in width and form the primitive cavities of the segments. The lateral portion of the inner layer which thus bounds these clefts forms, for the most part, the muscular layer of the mid-gut, while the median portion, becoming histologically differentiated, forms the epithelial layer of the same, becomes in fact the final endoderm layer. (*f*) The body-cavity, formed independently of the primitive segment cavities, appears as a cavity between the yolk and the somatic mesoderm layer. The details of these processes, and of others, such as the growth of the ectoderm round the yolk, are noted. It is interesting to note that just as the anterior and posterior defining of the furrow-like invagination originated independently, so the endoderm layer is formed in two separate anterior and posterior portions which subsequently grow together across the intervening gap.

Dr. Heider describes (*g*) the condition of the yolk with persisting cellular bodies, and with cells which wander inwards from the endo-mesoderm, and emphatically denies the frequently asserted formation of part of the internal layer from the apposition of nuclei from the yolk. The degeneration of the latter, and its absorption by pseudopodia-like processes from the endoderm cells is noted. While agreeing with Kowalevsky, as against numerous other investigators whose views he criticizes, as to the origin of the endoderm from the invaginated lower layer, Dr. Heider differs from him on two chief points—the origin of the primitive segment cavities and the mode in which the endoderm is separated off. For while Kowalevsky derives the former from internal and inferior foldings of the endo-mesoderm, and represents the folded portion as consisting of both endo- and mesoderm afterwards separated, Dr. Heider has described the origin of the cavities from a lateral split between the two layers of the invaginated compressed tube, and derives the endoderm from the median portion between them. This median portion afterwards grows in between the splanchnic mesoderm and the surface of the yolk, which then becomes enclosed dorsally and ventrally by the simple extensions of the two layers.

As subsidiary results of his research, Dr. Heider notes (*h*) that not only on the first abdominal segment, but on all the others rudimentary appendages can be observed; (*i*) that the transverse commissure of the ganglionic chain originates by the invagination between the lateral strands of a median portion retaining an intersegmental connection with the ectoderm, that the œsophageal commissure is formed from the anterior portion of the lateral cords without assistance from the mandibular ganglion, that the apical plates are

from the first in connection with the lateral cords, that the frontal ganglion is formed from an unpaired invagination independent of that which gives rise to the central nervous system; (*j*) that the dorsal canal described by Kowalevsky is an involution of the egg-membranes; (*k*) that the Malpighian vessels arise from the ectoderm as diverticula of the hind-gut.

The latter portion of Dr. Heider's memoir is occupied (*l*) with a lucid exposition of the opinion that the various germinal layers are derivable from the blastoderm which is superficially budded off from the giant multinuclear trophodic yolk-cell, which thus occupies the segmentation cavity. The gastrulation has the modified form of a long furrow, the boundary between the two layers of the endo-mesoderm represents the primitive enteric cavity, the margins of the invagination form the stretched-out blastopore. The persistence of nuclei within the yolk after the plastic elements have been differentiated, may be connected with the delayed absorption of the former. While regarding the yolk as the passive trophodic remnant comparable to that occupying the centre of a centrolecithally segmented ovum, the author does not exclude the possibility of its phylogenetic origin from modified endoderm segmentation masses, as suggested by Kowalevsky's report of what occurs in *Euaxes*.

Behaviour of Dorsal Vessel during Metamorphosis.*—Prof. A. Kowalevsky has studied in the larvæ of *Muscidæ* the behaviour of the dorsal blood-vessel during the metamorphosis of the larva. In feeding the larvæ, for another purpose, with cochineal, silver salts, and other colouring matters, he found that the pigment was passed in an apparently uncoloured combination to special cells lying round the heart, viz. (*a*) to the thirteen pairs of large cells lying posteriorly, (*b*) to the band-like masses which surround it medianly, and (*c*) to the anterior "garland-like strands" described by Weismann. Within these cells the pigment, passed doubtless from the heart by the blood, seems to enter into an insoluble combination with the plasma round about the nucleus. Prof. Kowalevsky is therefore inclined to attribute to these cells a blood-purifying function.

The "garland-like strands" persist unchanged for two days after metamorphosis, a fragmentation of the nucleus sets in, and the cells gradually fall a prey to the fagocytes or granular spheres within which the pigment again forms an uncoloured combination. The strands therefore form an altogether embryonic or larval gland, which does not pass on into the insect.

He has shown that the anterior and median portions of the heart completely pass over to the imago, and the cells enveloping the middle portion also persist, changing their position, however, and forming a broad mass of cells, which envelopes the anterior wall of the abdomen as a thick network. They retain their introduced pigment, and even in the adult insect these cells about the median portion of the heart may be artificially fed with colour in similar fashion.

* Biol. Centralbl., vi. (1886) pp. 74–9.

Of the thirteen pairs of large cells at the hinder end of the heart, the six posterior pairs, and probably the portion of the heart between them, fall victims to the voracity of the granular cells; but the seven anterior pairs persist. Prof. Kowalevsky draws attention finally to the important shifting of the heart from its deep position between the tracheal stems in the larval, to its subsequent superficial position just below the external epithelium.

Structure of the Honey-Bee's Cell.*—Herr K. Müllenhoff reports the results of his studies as to the influences resulting in the formation of the honey-bee's cell. Extending the old observation as to the optimum exhibited by the form of the cell, he shows how its length is also in perfect accord with the best solution of the bee's problem. As to mechanical explanation, he extends Buffon's experiment with the boiled bottled peas swollen into hexagonal form by mutual pressure, by showing that the general resultant figures are really rhombododecahedra, while those at the sides exhibit the exact form of the bee's cell. After referring to Darwin's, for the most part teleological attempt at solution, he directs attention to the necessity of considering the nature of the component substance, the behaviour of the bees, and the exact nature of the mechanical forces at work. This he has elsewhere discussed in detail.†

He emphasizes the perfectly plastic character of the wax at the temperature of comb-building (27°–37° C.), and distinguishes three different phases in the process:—(1) The formation of Maraldi's pyramids and short prisms, (2) the increase of the prisms to their full length, (3) the filling and closure of the cells. Describing the beginning of the process, he shows how the simple contractility of the material effects the disposition of the wax into small pellicles of equal strength, the perfect squaring of the walls, and the formation of surface angles of 120°. In describing the successive stages, he lays special stress on the variations which must follow the changes of temperature and the continued plasticity of the cell, which is continually tending to acquire smaller surface and stronger walls. The cells behave mutually like soap-bubbles. Maraldi's pyramids are literally Plateau's equilibrium figures—with the smallest surface within given limits, and the whole cells are isoperimetric figures—with smallest surface for given content. In short, not to any artistic dexterity on the part of the bee, nor to any direct effect of its body-form, but to "statical pressure according to the laws of equilibrium" is the beautiful result to be referred.

Storing and Preservation of Honey.‡—Herr K. Müllenhoff, continuing his studies of bees, has investigated the behaviour of the insect in gathering and storing the honey. He discusses the damping and the compression of the pollen, the marvellous adroitness of the bee in forcing its way into flowers, the careful avoidance of mixing the kind of pollen during one gathering, the renewed salivating and

* Arch. f. Anat. u. Physiol.—Physiol. Abtheil., 1886, pp. 371–5.
† Pflüger's Arch. f. d. Gesammt. Physiol., xxxii. (1883) pp. 589–618.
‡ Arch. f. Anat. u. Physiol.—Physiol. Abtheil., 1886, pp. 382–6.

compression which the pollen receives from the younger indoor workers before it is stored in the cells, which are always the cells of workers and not of drones. The pollen is frequently deposited in layers, and frequently hermetically sealed with honey, over which a thin pellicle, like a layer of cream on milk, is formed, and this can be pushed aside for the deposition of more honey or walked over without causing overflow.

The bees which are going up and down over the full cells often exhibit protruded stings, and that in normal circumstances. Drops of poison from the end of the sting are seen to be deposited on the honey, and the presence of formic acid, absent in pure nectar, is thus explained. The acid doubtless exerts an antiseptic influence on the honey, and the author has beautifully shown that in uncovered honey-cells none is present, and that fermentation soon sets in, which could, however, be prevented by the addition of 1/10 per cent. formic acid. Herr Müllenhoff suggests the possible expediency of removing the honey from the uncovered cells, and thus economizing the time and energy of the bees, while the honey could be readily and cheaply preserved by the addition of 1/10 per cent. formic acid from a pipette.

Palps of Mandibulate Insects.*—Prof. F. Plateau has observed fifty individuals belonging to various species of Coleoptera and Orthoptera, and he concludes that during manducation the labial and maxillary palps of mandibulate insects are inactive; the removal of the maxillary palps does not prevent them from eating in a normal manner, and the same is true of the loss of the labial palps. The amputation of the four palps does not abolish the sense of smell, nor destroy the power of the insects to recognize and seize their food. In fact, notwithstanding the loss of the four palps these insects eat in a perfectly normal manner. It will be noticed that the results of M. Plateau are altogether opposed to the views ordinarily held by entomologists as to the function of the palps.

Minute Structure of the Eyes of Diptera.†—The first part of Prof. G. O. Ciaccio's work consists of sixteen chapters, which treat of the eye of insects generally, of the methods of study, and of a description of the constituent parts of the eye. The second, in thirteen chapters, is devoted to the peculiarities of a number of families, among which are the Æstridæ, Syrphidæ, Muscidæ, Tabanidæ, Tipulidæ, and Pulicidæ. The third part is divided into five chapters and treats of simple and compound eyes and their relations to one another, and to those of vertebrates, and lastly, of the physiology of vision.

Luminous Elateridæ.‡—M. R. Dubois is of opinion that any generalization on the subject of biological luminosity is premature; for the present we must try and collect as large a number of facts as possible. The luminous Elateridæ are the animals which best lend

* Bull. Soc. Zool. France, x. (1885) pp. 67–90.
† Mem. Accad. Sci. Instit. Bologna, 1885, 28 pp. and 12 pls.
‡ Bull. Soc. Zool. France, xi. (1886) pp. 1–275 (9 pls.).

themselves to physiological analysis; they are found between 30° S. and 30° N. of latitude, and between 40° and 180° of longitude. The emission of light is intimately connected with the accomplishment of an important physiological function, but in some rare cases there is no luminosity. The position, form, and powers of the luminous organs vary slightly in different species, and a few have no such organs. One of the most brilliant is *Pyrophorus noctilucus*, which has been especially studied by M. Dubois. In the necessary preliminary anatomical study certain corrections were found to be necessary with regard to the situation of the stigmata, the distribution of the tracheæ, and the relations of the nervous system to the light-producing organs.

The organs themselves are composed of a special adipose tissue and of certain accessory organs; histochemical investigation revealed the presence of a body which presents the characters of guanin. Intense histolysis takes place within the photogenous adipose tissue, the changes being provoked or stimulated by the penetration of blood into the luminous organ; this histolytic process is accompanied by the formation, within the photogenic cell, of a vast number of small crystalline agglomerations of special optic properties, and especially remarkable for their double refraction.

The presence of blood is not, however, indispensable for the production of light, for the ovum is luminous, even before segmentation, and the adipose photogenic cell, when isolated, exhibits the same property; these facts point to a similarity between the substance of the adipose body and that of the vitellus. The larvæ, which, hitherto unknown, have been by the author found to resemble those of other Elateridæ, are luminous; at first they have but a single luminous organ, but this extends over all the segments, and is localized at the points where histolysis is most active. In the adult insect there are three luminous spots which are so placed as to aid walking, swimming, and flying in obscurity. The muscles of the luminous organs regulate the supply of blood to the photogenic organs, and so have an indirect action on the production of light; the nerves act through the muscles; the photosensitive reflex action has its seat in the cerebroid ganglia; centrifugal irritation of the ganglia produces the appearance of the light, but this is not the case with centripetal stimulation. Respiration has only an indirect influence on the photogenic function, and this by maintaining the vital conditions of the blood and of the tissues; the nature of the food has no influence on the production of animal light. The cell (the nonsegmented ovum, or the adipose cell) prepares the photogenic principles under the influence of nutrition, but the light is not the direct result of the proper activity of the organized and living anatomical element. When the structure of this anatomical element and its vitality are destroyed the luminous phenomenon can still be produced by a physico-chemical action, similar to that which converts glycogen into sugar in the liver. Though the luminous organs of *Pyrophorus* are the most remarkable known to us, the organic expense is almost insignificant as compared with the effect produced; so, too,

the loss of energy is very slight, whereas in artificial light it may be as much as 98 per cent.

The author analyses the causes of the admirable economic superiority, and ascribes it to the following causes:—

1. There are a number of chemical rays in this light as may be shown by photography, but there is only a small proportion of them; the result must be ascribed to the existence of a fluorescent substance which has been discovered in the blood of *Pyrophorus*, and which, by penetrating into the organ, gives it the special and brilliant character which distinguishes the light. The greater number of the chemical rays are transformed into very brilliant fluorescent rays of a medium wave-length.

2. Optic analysis shows that the light is in great part composed of rays similar to those which are found at those points of the spectrum where experience has fixed the maximum of illuminating intensity.

3. There is no loss by heat-radiation; the amount of heat given off, even at the time of greatest activity, is infinitesimal.

4. There is no reason for supposing that there is any conversion of energy into electricity.

5. This marvellous light is physiological because it is of vital origin, and because no other source is as well adapted to the wants of the organ of vision in the animal series.

Honey-dew.*—M. Boudier finds the composition of honey-dew from the *Aphis* of the laburnum to be as follows:—Cane-sugar 57·25; inverting sugar 16·25; dextrin, mucilaginous substances, albuminoids, &c., 26·5 per cent. It frequently contained Mucedineæ, which possibly, in their development, have transformed a portion of the cane-sugar into inverting sugar. In damp weather there are developed on the leaves covered with honey-dew large numbers of fungi belonging to the genus *Cladosporium*.

β. Myriopoda.

Early Development of Iulus terrestris.†—Mr. F. G. Heathcote experienced considerable difficulty in preparing the ova of *Iulus terrestris*, owing to the hard chitinous chorion and the great amount of food-yolk. Attempts to remove the chorion by Bobretski's method were failures; Perenyi's fluid burst the chorion quickly, but the contents escaped; in the result Mr. Heathcote cut sections of the ova with the chorion still on. The sections were most satisfactorily stained by Grenacher's alum-carmine.

The ovum, when within the ovary, is surrounded by a follicular envelope, has a large nucleus and a single large nucleolus, which stains very deeply. Sections made from ova late on the day of oviposi-

* Assoc. Fran. pour l'Avancement des Sci., Congrès de Blois, 1884, 8 pp. See Bull. Soc. Bot. France, xxxii. (1885) Rev. Bibl., pp. 122–3.

† Quart. Journ. Micr. Sci., xxvi. (1886) pp. 449–69 (2 pls.). Proc. Roy. Soc. Lond., xl. (1886) pp. 73–6.

tion revealed the nucleus not at the periphery, but in a mass of protoplasm in the centre of the ovum; from this mass amœba-like processes radiate in all directions, and form a protoplasmic network throughout the egg; the nucleus is no longer a distinct vesicle. Early on the second day the nucleus and the central mass of protoplasm divide into two parts, but the parts remain connected by a network of protoplasm. At the close of segmentation there are a number of masses, each with a dense central portion in which is the nucleus, while the outer portion is broken up into innumerable processes, which cement the masses together and permeate the yolk in every direction.

Mr. Heathcote attaches more importance to the connection of layer with layer by means of cell-processes than to the connection of cell with cell. He believes that nothing of the sort has been described before, but more than ten years ago Prof. Ray Lankester (in vol. xiv. Q. J. M. S.) directed attention to "an important histological arrangement seen" in a specimen of a developing *Lymnæus*, where there was "a connection of the endodermal mass of cells with those forming the body-wall by means of long processes . . . the processes appear to be actual filaments of the cell-substance of the endodermal cells." The mesodermal "keel" is formed both by ectoderm and endoderm; later on, the greater part of the mesoderm becomes arranged in two parallel longitudinal bands along the ventral surface of the embryo, and these bands are connected by a thin bilaminate portion; the mesodermal somites are at first solid, but later a cavity appears in them; the formation of the mesoderm almost exactly resembles that of spiders, as described by Balfour.

The nerve-cords are, at an early stage, widely separated from one another, but connected by a thin median portion; later on, they almost form one cord. The lumen of the Malpighian tubes is from the first continuous with that of the proctodæum. The author concludes by comparing his results with those of earlier observers on this and allied forms.

γ. Prototracheata.

Development of the Cape Species of Peripatus.* — Mr. A. Sedgwick enters into fuller details as to the development of *Peripatus* than in his communication to the Royal Society which we have already noticed.† Notwithstanding the sponge-like structure of the ovum of *P. capensis* it can hardly be doubted that some not very remote ancestor must have had an ovum heavily charged with food-yolk; in *P. novæ zealandiæ* the ovum is considerably larger (1·5 × 1 mm.) than that of *P. capensis*, and contains a large amount of food-yolk, while the shell is thick and chitinous. On the other hand, the West Indian species described by Kennel has a small ovum (0·04 mm.); so that we have in *P. novæ zealandiæ* with greatest

* Quart. Journ. Micr. Sci., xxvi. (1886) pp. 175–212 (3 pls.).

† See this Journal, *ante*, p. 239.

length of ovum 1·5, in *P. capensis* 0·5–0·6 mm., of *P. balfouri* 0·4–0·5 mm., and of *P. edwardsii* 0·04 mm., a perfect series in regard to size and amount of yolk.

As to the segmentation it is not only to be noted that it is not a true segmentation, but also that no part of the nucleus or centre of force of the unsegmented ovum enters the clear endoderm masses; when endodermal nuclei do appear, they are larger than the ectodermal and are very irregular in shape; dividing directly, they do not exhibit the usual karyokinetic figures. In other words, there are two different modes of segmentation, neither of which are instances of complete cleavage in the ordinary acceptation of the term. The first kind is preceded by the division of the nucleus of the fertilized ovum and its products, and this gives rise to the ectoderm cells; the second, which takes place contemporaneously with the first, divide the larger and cleaner vegetative part of the ovum with the endoderm masses. Inasmuch as the gut is to be looked upon as a vacuole, it resembles in all essential respects the cavity in the body of a ciliated infusorian.

After a full account of the nucleus of the unsegmented ovum, the male and female pronuclei and the endodermal nuclei are described in detail; the structure of the gastrula and the formation of the mesoderm are discussed, and, in conclusion, the author extends the results which flow from his discovery of the syncytial nature of *Peripatus*; if they are of general truth we must modify our ideas about the ancestral metazoon, and, instead of looking on it as a colonial protozoon, regard it as having the nature of a multinucleated infusorian, with a mouth leading into a central vacuolated mass of protoplasm. In centrolecithal eggs it has already been observed that in early stages separation was incomplete, but the ordinary explanation that this phase is only temporary is not confirmed by Heathcote's discovery that there is no separation in the myriopod *Iulus*.

δ. Arachnida.

Development of Agelena uævia.*—After a short review of the comparatively few works on the subject, Mr. W. A. Locy gives an account of his own researches.

1. *The eggs.*—Eggs in the fresh state were studied when immersed in pure oil; external features were also observed on eggs hardened in alcohol, after removing the shell and clarifying with oil of cloves. The most satisfactory method of preparing them for sections is to heat the eggs in water to 80° C., and after being slowly cooled, to pass them through a graduated series of alcohols. Perenyi's fluid produces an alteration in the yolk, but is useful in conjunction with other methods. Corrosive sublimate renders the eggs too brittle.

Grenacher's borax-carmine is the best staining agent, though in the later stages the egg has to remain in the fluid for a considerable

* Bull. Mus. Comp. Zool. Cambridge, xii. (1886) pp. 63-95 (12 pls.).

time, and in order to prevent maceration it has to be rehardened from time to time. Eggs heated with Perenyi's fluid gave the most satisfactory sections.

The egg when laid is surrounded by a tough chorion (deposited during the passage down the oviduct) which is covered with granules. Within this is a structureless vitelline membrane formed whilst the egg is still in the ovary.

In the centre of the egg is the nucleus surrounded by nearly clear protoplasm; this is connected by protoplasmic strands with a peripheral layer of protoplasm—the blastema—containing numerous oil-globules; imbedded in the meshes of the protoplasmic network connecting the two layers of protoplasm are numerous large albuminoid yolk-corpuscles.

2. *The embryo.*—The development of the embryo is, for convenience, divided into five periods.

The *preblastodermic period.*—The yolk shrinks from the vitelline membrane, and the space thus formed is filled with pervitelline liquid. In this condition one side—the future ventral plate—is flat, the other convex. The contraction of the yolk causes the blastema to be moulded on the underlying yolk-corpuscles, so as to mark out the surface of the egg into polygonal areas. The central nucleus divides up, and the nuclei thus formed, together with corresponding portions of protoplasm, migrate to the surface and enter the blastema; and thus this layer becomes converted into a series of nucleated cells—the blastoderm.

The *second period* includes the changes up to the first appearance of the appendages. The irregular cells of the blastoderm divide up and give rise to regular cells. In one instance the author observed a depression at one pole of the egg, similar to that described by Salensky as an invagination; but Locy is uncertain as to what really happens, and considers it to have some relation to the primitive cumulus. This latter structure is a thickening of the blastoderm at one end of the ventral surface. At the opposite end a caudal thickening appears, and between the two is the ventral plate. This is soon marked by transverse furrows into "protozonites." These extend laterally for about a quarter of the circumference of the egg, whilst the series of seven or eight zonites occupy about two-thirds the circumference. The blastoderm along the ventral surface is more than one cell layer thick, whereas dorsally there is a single layer of flattened cells. When the protozonites are formed, both ectoderm and mesoderm are distinguishable; the former as a layer of regular, columnar cells; the latter of cuboidal cells not so definitely arranged.

The *third period* extends from the appearance of the appendages to the time of reversion.

Six protozonites are distinguishable; these soon become rounded at their lateral extremities and project as bud-like processes—the appendages. The first two zonites are formed from the cephalic plate; new ones are added from the caudal plate. The four next zonites appear, and have small rounded prominences upon them—the provisional mesosomatic appendages. The prosomatic appendages

gradually curve towards the ventral surface and are distinctly four-jointed.

The cephalic plate is bilobed; a bilobed labrum has appeared and the stomodæum is faintly indicated between the rudiments of the cheliceræ. The head and tail nearly meet dorsally and the caudal plate has given rise to six metasomatic segments. The ectoderm along the ventral mid-line is thinner than at the sides, and it is from the thickened lateral bands that the nerve-ganglia are formed, one at the base of each of the appendages; those belonging to the cheliceræ will soon disappear. The mesoderm is absent in the middle line, but laterally it splits into somatic and splanchnic layers, and is divided up into segments.

In the *fourth period* the reversion takes place. The tail gradually becomes pointed and much shorter; the terga, which have appeared in the mesosomatic segments grow dorsally, and the tail gradually separates from the head on this surface.

As the terga grow this process goes on till at the end of this stage the ventral surface is bent upon itself, so that the tail is directed towards the head in exactly the opposite direction to what it is at the beginning of the period. The stomodæum is deepening; the proctodæum has appeared at the tip of the shortened tail, and gives off a diverticulum which becomes the stercoral pocket of the adult. During reversion the ectodermic bands, which give rise to the ganglia, become widely separated and allow some of the yolk to project, so as to form a sort of yolk-sac, which, however, is soon absorbed.

At the base of the cheliceræ certain cells become spongy and form the poison-gland, probably by invagination; the spinning glands are indicated by masses of ectoderm near the anus. Later on the invaginations to form the pulmonary sacs appear; the lamellæ arise from cells which become arranged in parallel lines. The mesoderm grows dorsally and becomes segmented, corresponding to the terga; so that these are not derived, as Balfour held, from the yolk. The author was unable to ascertain the details of the formation of the heart, but agrees with Schimkewitsch that Balfour's statement that it arises from a solid cord of cells is wrong. Just before reversion commences certain large cells are seen along the sides of the body, which have arisen from the yolk, and form the "primary entoderm."

The *fifth period* lasts up till the embryo is hatched. A deep constriction separates the prosoma from the mesosome, and the embryo becomes still more flexed. The two posterior pairs of provisional appendages are transformed into spinning mamillæ.

A few days before hatching the embryo begins to unroll and undergoes a moult, and when hatched is quite straight. The eyes have appeared, and the tracheæ are indicated as invaginations on the ventral surface.

3. *Organogeny.*—At the time of hatching, the alimentary tract consists of an anterior and a posterior portion, the inner ends of which abut on the yolk. The stomodæum gives rise to pharynx, œsophagus, and stomach, which are lined by a cuticle continuous with that of the exterior. The proctodæum gives rise to the stercoral pocket,

from which the prestercoral tube leads towards the yolk; the Malpighian tubes arise from its dorsal wall, and the author considers that their position marks the prestercoral tube as entodermic. Passing backwards from the stomach is the postgastric tube, which is so plugged with cells that its true relations are obscured; it is probably the most anterior region of the mesenteron, the middle region of which is still occupied by yolk.

The *eyes* are eight in number; the anterior median pair have a slightly different development from that of the remaining eyes. A thickening of the ectoderm appears, and at one end of this is an invagination, directed obliquely to the surface, so that the outer wall becomes inverted, whilst the cells of the lower wall retain their original direction; this consists of one layer, the inverted wall of several layers.

The epidermis meets above the invagination and gives rise to the vitreous body; the cuticle becomes thickened to form the lens; the cells of the inverted layer elongate and form the bacilli peripherally, whilst the nuclei get pushed deeper down, so as to be postbacillar; the lower wall of the optic cup appears to give four pigment-cells.

In the other eyes, the nuclei of the retina are prebacillar.

The *lung-sacs* arise as a pair of invaginations, and the lamellæ are first indicated by the nuclei of the cells being arranged in parallel rows; the cells give rise to a chitinous cuticle which coats the lamellæ.

At the end of the paper some results and theories of previous authors are discussed in the light of the new facts observed by the present author, and a bibliography closes the memoir.

ε. Crustacea.

Structure and Development of Branchipus and Artemia.*— What Prof. C. Claus did long ago for the Schizopoda in his monograph on *Nebalia*, he has now even more completely achieved for the Phyllopods in a detailed investigation of the structure and development of *Branchipus*, nor is his research without rich results in regard to the Malacostraca in general.

I. *The formation of metameres and the development of the body during metamorphosis.* — The newly liberated *Branchipus* larva, though predominantly nauplioid, already exhibits hints of the metanauplius stage, in the presence, below the cuticle, of the maxillary segments, of pad-like appendages on the next two joints, and of metameric segmenting of the mesoderm band in the posterior portion. On cross-section the cerebral and mandibular ganglia are seen still connected with the ectoderm, the œsophageal ring and antennary ganglia have already sunk inwards, while antennary gland, liver diverticula, mouth, and hind-gut are readily apparent. The splanchnic

* Arbeit. Zool. Inst. Univ. Wien, vi. (1886) pp. 267–370 (12 pls.).

mesoblast develops, in characteristic crustacean fashion, independently of the somites, into which the parietal sheath becomes subsequently segmented. The growth of the mesoblast, the appearance of the lateral appendage-rudiments and alternating ganglia, the mesoblast growth round the dorsal vessel, and the progressive differentiation of the organs is then described in detail for larvæ at various successive stages. The presence of a hitherto overlooked sense-organ between the brain and the frontal eye is noted.

II. *The segmentation of the mesoderm and the differentiation of ectodermic and mesodermic organs.*—The posterior portion of the mesoderm band, Prof. Claus calls the budding zone. In front of this, cross bands of two cells abreast are formed, rapidly growing, by the division of these cells, into thick mesoderm somites, in which three regions become more or less clearly distinguishable—the dorsal, forming the heart-rudiment and dorsal muscles—the median or lateral forming the musculature of the joints—the ventral forming muscle and neurilemma. The connective tissue of the horizontal septum, the blood-corpuscles, &c., are similarly derived. The first rudiments of the appendages are due to ectoderm proliferations which soon become associated with mesoderm. It is worth noting that except in the testicular cells no nuclear spindles were seen, so that direct division is regarded as normal. The rudiments of the ganglia are at first separate ectodermal thickenings, which, sinking in, become secondarily connected. In no case does a nerve arise as a secondary outgrowth from the nerve centre; only the frontal sense-organ seems to develope in this way from processes of the frontal nerve-cells of the cerebral ganglion. The grouping of the muscle-cells in definite direction is then described.

III. *The formation of regions and the number of the segments.*—The impossibility of establishing exact homologies between the variable adaptive modifications into head, thorax, and abdomen in different types is emphasized. Entering into a detailed discussion of the number of segments, Prof. Claus criticizes the famous experiment of Schmankewitsch, maintaining that there is really no difference in the number of abdominal segments, while there are indeed numerous distinctions between the two genera.

IV. *Integument, connective-tissue, and fat-bodies.*—*Branchipus* affords beautiful illustration of the chitinous modification of part of the protoplasm of the hypodermis cells to form not only the cuticle, but the sinews and internal plates. The three layers described in Decapods are not differentiated in *Branchipus*, where the external structureless cuticle is generally alone discoverable, though in some regions a deeper fibrous layer can be detected. It seems sometimes as if the connective-tissue structures which Tullberg described, in the lobster, between the chitinogenous cells and the subjacent connective tissue, were really present, but this appearance is due to a non-nucleated internal cuticle, resulting from the modified basal protoplasm of the epithelial cells. Connective fibres abundantly distributed in the joints are also products of the chitinogenous cells

of the hypodermis, and are not strictly connective-tissue fibres. The fibrous strands and sinew-plates produced within the chitinogenous cells are micro-chemically distinguishable from the superficial chitin of the cuticle. The mesoderm connective-tissue elements are then discussed, and the special modification of these by the accumulation of fatty globules within the protoplasm. The various distribution of the fatty cells and the parts that they seem to discharge, for instance, in aiding the chitinized basal membrane of the hypodermis cells to form the sinew-plates are described at length.

V. *Musculature.*—Two dorsal muscles extend along the blood-vessel, and two ventral along the nerve-cord; the external bundles of the latter diverge dorsally in the segments behind the genital region; the myomere of the last abdominal segment is well defined from the anal piece (not in *Artemia*), but several long muscle-cells pass into the latter. The lateral-dorsal, and the median-ventral groups of transverse muscles, and the disposition of the component bundles in each appendage-bearing segment are described, and compared with the homologous musculature of the maxillæ, and with the more complicated modifications in the second antennary and mandibular segments. Special attention is directed to the interesting connection between the muscles themselves and with the integument, by means of numerous sinewy connective fibres which distribute the strain over a large surface of insertion.

VI. *Nervous system and sense-organs.*—*Branchipus*, like other Phyllopoda, affords beautiful illustration of the rope-ladder-like nerve chain, produced by the marked distance of the two ganglionated cord and the consequent breadth of the transverse commissure. The position of the antennary ganglia on the œsophageal ring and the persistent separation of the mandibular and maxillary ganglia, are also regarded as expressions of primitive characters. With the exception of that connecting the mandibular ganglia, the commissures of the above ganglia are double, as are also those of the two pairs of small ganglia in the genital segments. Prof. Claus gives reasons for regarding the primary cerebral ganglion mass as referable to the apical disc of Lovén's larva, while the ganglia of the segments owe their origin to paired thickenings of the hypodermis. He gives a minute description of the structure and histology of these supra-œsophageal nervous structures, of the sensory setæ on the antennæ, &c., and of a hitherto unobserved sense-organ, similar to that structure in *Cladocera* first described by Leydig as "Nackenorgan."

VII. *The stalked eyes.*—Prof. Claus emphasizes what even Carrière in his recent work on the comparative anatomy of optic organs overlooks, that the compound lateral eyes of *Branchipus* are seated on movable stalks, and indicates the great interest of their relatively simple relations as elucidating the more complex structures and connections in the eyes of Decapods and Stomatopods. After noting the perfect homology of the eyes of *Branchipus* with those of these higher types, and reasserting his previously maintained derivation of these organs from parts of the head which have become

independent, and not from modified appendages as was formerly asserted, he indicates the origin of their ganglion from the distally constricted portion of the dorsal cerebral lobe (the secondary cerebrum). A detailed comparative account of the innervation and histology of these lateral eyes is then given, with critical notices of the opinions of Grenacher, Carrière, and others.

VIII. *The unpaired frontal eye* is then described; and in regard to its function, it is noted that while the absence of a refracting apparatus seems to exclude the possibility of the perception of images, and points, therefore, to a diffuse sensitiveness to light, the slight differentiation of the nerve-cells suggests the probability that its function is restricted to a susceptibility to the heat-rays of light.

IX. *Alimentary and excretory organs.*—After some notes in regard to the oral appendages, in the course of which the absence of a mandibular palp is emphasized as a general character of the Phyllopods, and a description of the alimentary tract, with a denial of the respiratory function of the hind-gut, Prof. Claus discusses at some length the antennary and the shell-glands, as also the interesting segmental, ventral, and limb "glands," and lastly the "Nackenschild."

X. *Heart, circulation and respiration.*—In regard to the structure and development of the primitive type of heart exhibited by *Branchipus*, Professor Claus has little to add to his previously established results. The same may be said as to the respiration; as before, he maintains, apart from the respiratory function of the whole of the delicate integument, that the branchial sacks on the appendages are special breathing organs. As noted above, he does not allow to the intestinal surface that respiratory function with which it has been repeatedly credited.

XI. *Reproductive organs.*—The modification of genital segments and external organs, and the structure of the male and female glands, are finally discussed, and on the former point a further report is promised.

Of this detailed monograph of the much-investigated *Branchipus*, which occupies a whole part of the Wien Arbeiten, little more than a table of contents has been above given. The memoir is illustrated with twelve plates.

'Challenger' Stomatopoda.*—Mr. W. K. Brooks gives a *résumé* of his report on this group published in the "Challenger" Reports.

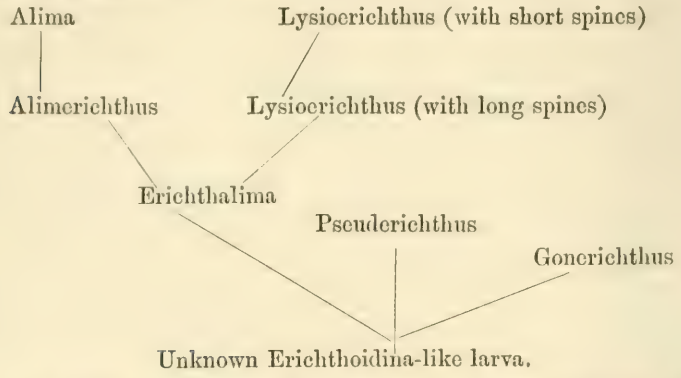
Out of fifteen adult species eight are new, and two have been only inadequately described. The pelagic larvæ are numerous, and have served to establish the connection between the adults and their proper larvæ in all the genera except two.

The development, however, is difficult to trace; they undergo secondary modifications which are not represented in the adult; in fact, the larvæ differ more from one another than do the adults.

From a comparative study of the larvæ, it is possible, as with the

* Johns-Hopkins Univ. Circ., v. (1886) pp. 83-5.

adults, to arrange them genealogically, as the following tabular arrangement shows:—

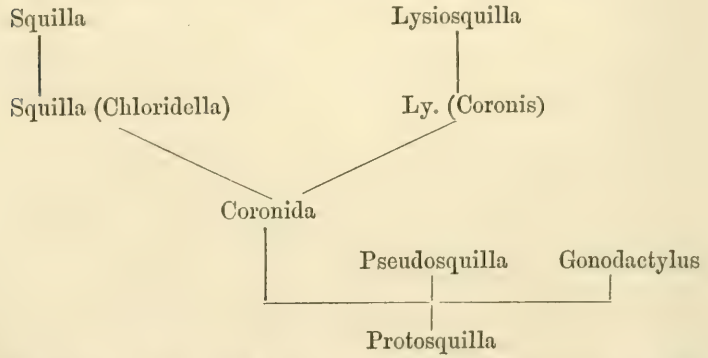


The generic characters are then given: while retaining the accepted genera new diagnoses are rendered necessary, since important points have been too greatly emphasized. Then follows an analytical key, giving the more prominent diagnostic characters of each genus.

1. Sixth abdominal somite fused with telson (gen. *Protosquilla* n.g.).
2. This somite distinct.

Genera, Gonodactylus.
Pseudosquilla.
Coronida n.g.
Lysiosquilla.
Squilla.

A phylogenetic table of the adult takes the following form:—



This table agrees with that derived from consideration of the larvæ. Faxon has reared a *Squilla empusa* from *Alima;* Claus has traced *Pseudosquilla* from *Pseuderichthus;* and Brooks has now traced

Lysiosquilla excavatus from a long-spined *Lysioerichthus*, *L. maculata* from a similar larva with short spines, *Gonodactylus* from *Gonerichthus;* and probably *Erichthalima* is a young *Coronida*.

New Isopod.*—Dr. R. Koehler proposes the name of *Jæropsis brevicornis* for a new Isopod which he found in the island of Sark, where it lives among sponges and simple Ascidians. As its name implies it stands nearest to *Jæra*, from which it differs essentially by the characters of its antennæ. It is from 2 to 2·75 mm. long; the seven thoracic somites are separated from one another, at the sides, by spaces of some size; the integuments are colourless, save near the head, where there is a large brown spot. The head is large and quadrilateral; the lower antennæ have a peduncle composed of four joints, the first of which is very short; the second is longer, but wider than long, and swollen along its outer edge; the third is almost triangular, and is, as it were, placed in an angle between the second and fourth joints; the fourth joint is oval; the flagellum of this antenna is very short, and is made up of seven or eight rings which decrease rapidly in size from the proximal to the distal. The superior antennæ have a peduncle of five joints and no flagellum. In a number of characters the new genus resembles *Jæra*, but in addition to those already mentioned, it differs also in the form of the maxillipeds, and in the appendages of the sixth abdominal segment.

Entoniscus mœnadis.†—M. A. Giard found an *Entoniscus* on the left side of a *Carcinus mœnas*, in the midst of the hepatic cæca of its host. It differs from *E. cavolinii*, not only in colour but also by the characters of its embryo; this has no nauplius-eye, and there are differences in the lateral eyes. M. Giard accepts the theory of protandrous hermaphroditism with regard to *Hemioniscus*, *Entoniscus*, and other less abnormal Bopyridæ.

MM. A. Giard and J. Bonnier also report‡ that the cuticle of *Entoniscus* is covered with small chitinous hairs, which are, no doubt, destined to aid the movements of the parasite in its host; in the caudal region the enveloping membrane which belongs to the crab is strengthened by a chitinous secretion, in which there is an orifice by means of which the parasite is put into communication with the branchial cavity of the crab. The incubation-cavity is more complicated than Kossmann supposes. The authors' studies on development have been few, but they are able to say that invagination is epibolic. *E. Kossmanni* found on *Portumnus variegatus*, and *E. fraissi* on *P. holsatus*, are new species.

Australian Fresh-water Entomostraca.§—Prof. G. S. Brady gives a list of the species of fresh-water Entomostraca that have already been described from Australia, and an account of fifteen species, eleven of which are new; these last belong to the genera *Limnetis*, *Eulimnadia*, *Estheria*, *Cypris*, *Chlamydotheca*, *Cydridopsis*, *Notodromos*, and *Candona*.

* Ann. Sci. Nat. Zool., xix. (1885) Art. 1, 7 pp. (1 pl.).
† Comptes Rendus, cii. (1886) pp. 1034–6.
‡ Tom. cit., pp. 1173–6.
§ Proc. Zool. Soc., 1886, pp. 82–93 (3 pls.).

Orientation of Sacculina carcini.*—M. A. Giard deals with some criticisms of M. Yves Delage. M. Giard has urged that *Sacculina carcini* can only be explained on the theory of modified descent, by supposing that the parasite of the symmetrical crab is derived from a *Peltogaster* parasitic on an anomurous form with twisted tail, which was the ancestor of the Paguridæ. In answer to M. Delage's objection that it is impossible to accept the theory of the derivation of the Brachyura from the Paguridæ, it is answered that all that is necessary is to show that the Paguridæ have given rise to certain crabs with a symmetrical abdomen; this has been demonstrated by Boas, who has shown that *Lithodes* is really descended from *Eupagurus*, and *Birgus* from *Cœnobita* and the Paguridæ.

Against the explanation offered by Delage that the movement of rotation which sets the axis of the *Sacculina* perpendicular to that of the crab is due to the right receiving more nourishment than the left side, it is sufficient to cite the case of *Sacculina benedeni*, which attaches itself to *Grapsus;* in this crab the unpaired cæcum opens from below the point where the *Sacculina* is ordinarily found, and yet the parasite presents just the same characters as in *Carcinus mænas*. As to the term to be applied to these parasites, no organ of the *Sacculina*, except the roots, can be properly said to be internal; the epithet is good for a certain time, from the topographical point of view, but it is not exact as a morphological application. The method of teasing out the intestine of the crab is too coarse, and has led M. Delage into error.

M. Y. Delage resents† M. Giard's criticism, but no new facts are contributed.

Vermes.

Generative Organs of Earthworms.‡—In all the species of *Lumbricus* examined by Dr. R. S. Bergh the gonads were found to be in the segments described by Hering. They agree in structure, but the testes vary in form in various species more than the ovary does. The gonads appear during the last period within the cocoon, and have at first the same appearance and structure. Arising as club-shaped thickenings of the peritoneum, they very early become differentiated into a thin epithelial cortex (peritoneum) and an internal mass of primitive germinal cells with peculiar large nuclei.

With regard to the anatomical relation of the seminal vesicles the species of *Lumbricus* fall into two groups, which appear to harmonize well with the divisions which have been instituted by systematists. In *L. terrestris* there is a median unpaired vesicle in the ninth and tenth segments, which invests the testes, seminal infundibula, and ventral chain. With this there are connected three pairs of appendages, which lie in the eighth, tenth, and eleventh segments. A similar arrangement is found in *L. purpureus*, and, according to Hering, in *L. rubellus*. In other species (*L. fœtidus*, *L. riparius*, *L. turgidus*, *L. mucosus*), there is no indication of an unpaired median vesicle, but

* Comptes Rendus, cii. (1886) pp. 1082–5.
† Ibid, pp. 1336–8.
‡ Zool. Anzeig., ix. (1886) pp. 231–5.

there are four pairs of vesiculæ seminales in the eighth to eleventh segments.

The origin of the paired vesicles has been investigated in *L. turgidus*. They do not, as Lankester supposed, arise as outgrowths from the seminal funnels, but are developed quite independently of these. They are formed as folds of the dissepiments, and the two anterior project forwards, and the two posterior backwards. The appendages of the median vesicle of *L. terrestris* arise in just the same way, but it is not yet made out how this vesicle itself is formed.

The receptaculum ovorum collects the ova until a sufficient number have been given off from the ovary to be laid. This was correctly explained by Hering in *L. turgidus*. It has primitively no connection with the oviduct or the funnels, but arises in just the same way as the paired vesiculæ seminales, with which it is completely homologous. Later on, however, it becomes connected with the oviducal funnel.

The receptacula seminis present variations in number and position, and never appear till very late. They are primitively invaginations of the epidermis of the intersegmental groove, but this invagination merely gives rise to the epithelium of the receptacle. The peritoneum forms their outer muscular layer, and they cannot be regarded as segmental organs, as Lankester and others suppose.

In a postscript the author gives an account of his examination of two species of *Perichæta*. The testes and ovaries are in exactly the same segments as in *Lumbricus*, but the former have undergone a peculiar dislocation, for they are not now placed directly on the hinder aspect of the special septa, but are removed from them, and, with the seminal infundibula, lie enclosed in a capsule of connective tissue. The testes have just the same structure as those of *L. turgidus*. There are two pairs of vesiculæ seminales (these have been previously described as testes), which open into the capsule. The ovaries are remarkable for consisting of a number of cylindrical ovarian cords radiating from a common base ; as this allows of a number of ova being given off at once there are no receptacula ovorum. The oviducts open to the exterior by a common orifice on the thirteenth segment. In one ("Horst's") species there are four pairs, and in the other two pairs of seminal pouches.

Ovum of Clepsine and Gnathobdellidæ.*—Dr. R. S. Bergh finds that the ova of *Clepsine* are well adapted for embryological investigations, owing to their large size and the ease with which they can be prepared. He finds that the trunk-germs, and therefore the whole of the trunk of the leech (with the exception of the midgut), arise from the fourth larger cleavage sphere, while the cephalic germs are to be referred to the smaller blastomeres. Each of these primary rudiments is afterwards differentiated into ectoderm and mesoderm. The author makes some criticisms on the results of Whitman and Nusbaum.

Leeches of Japan.†—Dr. C. O. Whitman in his first paper on the leeches of Japan, treats of the Hirudinidæ or ten-eyed leeches. In

* Zool. Anzeig., ix. (1886) pp. 112–9.

† Quart. Journ. Micr. Sci., xxvi. (1886) pp. 317–416 (5 pls.).

it considerable attention is given to a comparative study of the different genera, with the object of finding a more satisfactory basis for classification than any yet employed. All the Hirudinidæ agree in having twenty-six somites between the first pair of eyes and the acetabulum. There is a general law of abbreviation which is true of both ends of the leech, and the extent of this, which consists in the suppression of from one to four of the less important rings in the extreme somites, not only furnishes excellent means for distinguishing genera and species, but also gives a key to their phylogenetic relationship. The land-leech (*Hæmadipsa*) is first considered. *H. japonica* is a new species. The author points out that the land-leech, in abandoning the aquatic mode of life, became more and more adapted for creeping till at last the power of swimming was completely lost. This change in habit was accompanied by adaptive changes in size, form, and proportions; the centre of gravity travelled backwards nearer to the posterior sucker, while muscular power became more and more concentrated. The nephridial vesicles are capacious sacs, and experiment shows that fluid can be discharged from the nephridia for the purpose of moistening the surface of the body. The skin-glands are more numerous and the nephridial vesicles more capacious in terrestrial than in aquatic leeches. Further, the nephridial pores are marginal, and not latero-ventral in position, as are those of *Hirudo*. In all land-leeches which have been examined by Dr. Whitman, there have been noted the absence of an eyeless ring between the two rings which bear the third and fourth pairs of eyes; the marginal position of the nephridial pores; the large size of the vesicles; and the peculiar lobes which cover the posterior pair of pores. All these characters appear to be due to the change of respiratory medium, but the land-leeches still require to live in air which is loaded with water; they are animals "still on the road to terrestrial life." *Hirudo nipponia* sp. n. is next described, and the discussion of its characters leads the author to give a revised definition of the genus *Hirudo*. With it he compares *Aulostoma* and *Hæmopis*, the latter of which he proposes to replace in *Hirudo*, the comparative number of denticles being of no importance in the definition of a generic group of the Hirudinidæ.

By a comparison of *Hirudo medicinalis*, *Aulostoma*, *Hirudinaria javanica* and *Leptosoma* (g. n.), the author illustrates the value of the somites as a basis for classification. This last-named form has fewer abbreviated somites than the other forms described, and so shows that it is more primitive than any known Hirudinid. The fact that the denticles are rudimentary or absent suggests affinity to *Aulostoma*, but the latter is clearly an offshoot of *Hirudo*, so the edentulous condition must be supposed to have been acquired independently. *L. pigrum*, *L. edentulum*, and *L. acranulatum* are the new species of this new genus. The generic and specific characters of *Macrobdella sestertia* are fully given.

In conclusion Dr. Whitman speaks of the segmental papillæ, which, as he has already taught us, are serially homologous with the eyes. They are sense-organs, and from them the eyes are developed, so that they may be regarded as incipient eye-spots. These segmental

organs do not appear to have given rise to the non-segmental organs which are limited to a specialized part, and have arisen in response to the increased needs of their possessor. In the land-leech it is possible that, in addition to distinguishing between light and darkness, the segmental organs have some olfactory function, but this does not appear to hold good for *Macrobdella*.

Metamorphosis of Aulostoma gulo.*—Dr. R. S. Bergh describes the larva of *Aulostoma gulo* as varying in size, and having an oval form of body in which the body-wall and enteric wall are widely separated from one another; the œsophagus lies on the ventral surface, and may be single or divisible into pharynx and œsophagus proper; behind the mantle are the stripe-like fused trunk-rudiments, and at the sides of these the four pairs of circular primitive kidneys; all the structures of the larva fall into two distinct categories, those which have already specific functions, and those which are still indifferent cell-masses. To the former group there belong the primitive epidermis and the subjacent muscular and nervous cells of the body-wall, the enteric canal, and the primitive kidneys; to the latter the head and trunk-germs.

The primitive ectoderm is a simple flattened epithelium, the boundaries of the constituent cells of which are not apparent; the musculature consists of two different kinds of smooth elements; some are small and closely packed, the others are large and do not form a true muscular layer, their cells being separated from one another by rather broad intermediate spaces; they are, as a rule, arranged transversely, and so appear to form the circular muscle of the body. The excellent description given by Leuckart of the muscular system of the larva of the medicinal leech agrees essentially with that of *Aulostoma*. Cells which are apparently nervous in nature are to be found scattered between the muscle-fibres; they are spindle-shaped or much branched, and their processes are often exceedingly long and fine. The enteric canal is divisible into an anterior œsophageal portion and a midgut, which ends blindly; the former has a surprisingly complicated structure, for it consists of four distinct layers: an epithelial without distinct cell-boundaries, a layer of circular and then a layer of radial muscular cells, and an outer layer of epithelium. The midgut has the form of a simple sack which occupies by far the greater part of the cavity of the body; its walls are simple in structure.

The four pairs of primitive kidneys, which are ventral in position, are circular closed organs, formed of two rows of cells; in the anterior pairs a canalicular structure can be easily made out, and here and there there are anastomosing tubular spaces; the cell-boundaries, however, are indistinct, and the cells elongated.

The head-germs lie in front of the œsophagus, between it and the epidermis, and have, at an early stage, a broad tri- or quadri-lobate form; they early unite with one another, as do also (in contra-distinction to *Nephelis*) the trunk-germs; these latter are much better

* Arbeit. Zool.-Zoot. Inst. Würzburg, vii. (1886) pp. 231–91 (4 pls.).

developed than the head-germs; they extend as far as the hinder end of the pharynx, and are not connected with those of the head; posteriorly they terminate a little short of the hinder end of the larval body. They are at first separate, but later on they fuse, at first in their hinder and then in their anterior portion. From their outer margin the primitive kidneys are budded off, as simple rows of cells, each of which forms a swelling at the lateral margin, and still later separates from the germ. The history of the kidneys is given in detail.

The author prefaces his account of the formation of the body of the adult by a statement of the views held by earlier writers; he himself finds that the primitive œsophagus, like the primitive ectoderm, is a provisional transitory structure, no signs of which are to be found in the adult; instead thereof there is formed by the union of the head and trunk-germs, and the invagination which takes place at the point where the primitive mouth was situated, the permanent œsophagus of the leech. In the Gnathobdellida the hind-gut is not formed by the invagination of the primitive epidermis, but as a growth from the trunk-germs. Of the larval body nothing remains but the endoderm, and the body of the leech is formed by the hind and trunk-germs, which grow around the epithelium of the midgut.

After a critical review of what has been effected by his predecessors, the author considers the question of the typical development of the Annulata; the first important point is that the body is wholly or partially built up of two pairs of germs, an anterior and a posterior, which are, histologically, exactly similar, and which grow around the mouth and enteron. In the clearest cases (Nemertines, Leeches) there are four primitively common collective structures which contain the rudiments of all the tissues and organs, and from which the definite layers and tissues are only secondarily differentiated. This "scheme" is essentially that of those whose ova are provided with a small quantity of nutrient yolk, and they must be regarded as the typical, since all can be easily referred to them. Though this might seem to show that the Nemertinea and Hirudinea are closely allied, the author regards the latter as true Annelids; he finds an explanation in the fact that the Nemertinea have the simplest, and the Hirudinea the most specialized mode of development.

In the Nemertinea all the tissues of the body (with the exception of a part of the enteric epithelium, and, perhaps, the lateral organs) are typically formed from five germs, which (in *Pilidium*) arise as hollow invaginations of the primitive ectoderm and grow around the mouth. There is a late differentiation of the various parts in the larvæ. In the Polychæta and Oligochæta the four germs are from the first differentiated into two parts, so that there are, so to speak, eight germs; these do not arise as hollow invaginations, but as solid growths of the ectoderm, and the distinction between the provisional and the permanent epidermis is no longer possible; there is a partial early differentiation. In the Leeches this early differen-

tiation is not partial, but complete; at least for the trunk-germs; Bergh has shown that the ten cells which appear during cleavage give rise to them. Here again there is a distinction between provisional and permanent epidermis, and the similarity to the Nemertinea is due to the secondary union of the permanent ecto- and mesoderm.

The investigations which the author has been able to make into the history of the development of the earthworm have shown him the accuracy of many of Kleinenberg's statements, and have convinced him that the trunk-germs of leeches are not, as is ordinarily supposed, exactly homologous with the mesodermal stripes of *Lumbricus*, but that the latter structures correspond to a part of what are contained in the former.

Structure of the Glandular Ventricle of Syllis.*—Mr. W. A. Haswell prefers the term gizzard for that part of the digestive tract of the Syllidæ which has been called glandular ventricle, for he finds that there are no glands in the walls of this organ, but rather muscles; these have been supposed to be glands (possibly) because they form hollow columns of striated muscle; the transverse striæ are better marked in some than in other species. As to the constituent elements, it is found that they retain an embryonic structure inasmuch as there is a polynucleated core; this is of a red colour in a fresh state, like nearly all the protoplasmic elements of the body of the annelid. In one species the fibrils were seen to be formed by the linear coalescence of rows of the large rounded granules of which the main substance of the core is composed. Mr. Haswell reminds us that hollow polynucleated fibres of striated muscle-substance are found in various vertebrates, as an embryonic condition of the solid fibres, and in certain insects and arachnids as a permanent form. Simple (mononucleated) hollow fibres are not unfrequently found in various Vermes, and are in some cases transversely striated.

Ovaries and Oviducts of Eudrilus.†—Mr. F. E. Beddard directs attention to the fact that in a species of *Eudrilus* the oviduct is perfectly continuous with the ovary; this is novel to the whole group of Chætopoda, and resembles the arrangement seen in Platyhelminths and Hirudinea.

New Ichthyobdellid.‡—M. R. Saint-Loup describes a new form of ichthyobdellid—*Scorpænobdella elegans*, which was found parasitic on *Scorpæna scrofa*. It is 35 mm. long and 2 mm. wide behind the oral sucker, and is of a brownish colour with black dots and larger white patches. The walls of the body exhibit the typical hirudinid arrangement, the digestive tube is remarkable for the absence of any metameric divisions; there are no lateral ramifications and no constrictions; there is a proboscis connected by two muscular bundles with the walls of the body; the posterior portion (cloaca) is remark-

* Quart. Journ. Micr. Sci., xxvi. (1886) pp. 471–9 (1 pl.).
† Zool. Anzeig., ix. (1886) pp. 342–4.
‡ Comptes Rendus, cii. (1886) pp. 1180–3.

able for communicating with two lateral canals; these canals pass forwards for about 6 or 7 mm.; this is an arrangement which has not been described in any other leech.

The cervical part of the nervous system is reduced to a commissure; and the epidermis is segmented in metameres corresponding to those of the nervous system. There are five pairs of testicles, and two saccular ovaries. Glands comparable in form and position to what are ordinarily called salivary glands are to be found in the anterior region of the body, between its walls and the proboscis.

'Challenger' Polychæta.*—An elaborate report on the Polychæta collected during the voyage of H.M.S. 'Challenger' has been published by Prof. W. C. M'Intosh; the series is described as being extensive; no representatives of new families were found, but there are 220 new species. In addition to the technical descriptions of the forms, whether old or new, there are accounts of the eyes of the Alciopidæ and Phyllodocidæ by Dr. R. Marcus Gunn. The report is indispensable to all workers on Annelids.

Embryology of the Nemertinea.†—Prof. A. A. W. Hubrecht here gives the English reader an account of his observations on the development of *Lineus obscurus*, which were published last year in Dutch.‡ Four discs, and subsequently a fifth, are formed by the epiblast; the former are due to the cubical epiblast-cells dividing lengthways, becoming overcapped by the surrounding epiblast and soon completely enclosed within it. The fifth disc appears thus; in the aboral region of the epiblast the epiblast-cells are very distinctly delaminated, and a double layer is formed which finally separates; all the five discs are one cell-layer thick, and they increase in size by continued division of the constituent cells; finally they meet along their edges; they then unite and form the continuous coat of secondary integument, outside of which the primary epiblast is very soon cast off. Only at first is the hypoblast a distinct unicellular layer; later on its walls become less distinct; by budding mesoblast-cells are developed, which perform amœboid movements in the blastocœl into which they escape; some of them arise from the epiblast and some from the hypoblast, and there is no definite localization of this process. It was noted that the chromatic nuclear substance of the primary epiblast diminishes near the time when it is going to be cast off; this decrease in the significance of the primary epiblast as a formative element becomes more and more marked as the young larva within it increases in size.

Prof. Hubrecht is of opinion that the primary epiblast is not disintegrated, but that the greater part of it is carried off by the mesoblast cells or plays a further part in the formation of the larva. No portion of the central nervous system of *Lineus* takes its origin from either primary or secondary epiblast, but the whole nervous system is of mesoblastic origin. At first the archenteron communicates with the

* Reports of the voyage of H.M.S. 'Challenger,' xii. (1885), xi. and 554 pp. and 94 pls.

† Quart. Journ. Micr. Sci., xxvi. (1886) pp. 417–48 (1 pl.).

‡ 4to, Utrecht, 1885.

enteron by a wide blastopore, but later on the cavity of that portion of the intestine which grows backwards is closed anteriorly, and in front of this another portion of the embryonic intestine constantly remains in open communication with the exterior; the anterior fore-gut opens by a crescentic slit, and this would seem to become the mouth of the adult; in other words, there is no epiblastic stomodœum; part of the fore-gut becomes the œsophagus, and the rest appears to be converted into the nephridial system. The nephridia seem to long remain in a more or less embryonic phase, but their history is very difficult to make out, and is as yet only incompletely known.

The mesoblast cells, once freely moving about in the blastocœl, soon accumulate against the inner surface of the plates of secondary epiblast, and the mass increases in size. The process of differentiation leads to the appearance of muscle- and nerve-cells at a very early date; the mesoblast cells form a massive group in the prostomium, and a comparatively thin cell-sheet in the rest of the body.

Unexpected as is the mesoblastic origin of the nervous system, there appears to be no doubt about it; Hubrecht, indeed, thinks that Salensky's figures of *Amphiporus viviparus* point to the mesoblastic origin of the nervous system in that animal rather than to the mode of origin approved by Salensky. An account is given of the other organs which are developed from the middle germinal layer, and, in conclusion, there are some observations on the differences between an archicœlic and a schizocœlic cavity; as to the latter term great care must be used in its application, and the extension made by the Hertwigs is unfortunate. An *archicœl* is the term to be used when, as with *Limax*, it is obvious that the cavity has been present from the beginning, while that of schizocœl may be reserved for those cases where it can be demonstrated that the perivisceral cavity originates by a process of active scission, and when this scission cannot be looked on as a derivate either of archi- or entero-cœl.

Filaria terminalis.*—Count N. Passerini describes the anatomy and development of a Nematode found very abundantly in the lungs of rabbits, and named by him *Filaria terminalis*. After discussing the pathological state of the host, he gives a diagnosis of the parasite in the following terms:—the body is cylindrical, filiform, elongated, and transversely striated; the sexes are separate; the head has an obtuse form, and is not distinctly separated from the rest of the body; the terminal, circular mouth is surrounded by six papillæ; the anus lies ventrally and posteriorly, in front of a short, membranous, subconical tail; the extremity of the male is a little curved forward, and is furnished with a chitinous retractile penis formed of four pieces, of which the two terminal are slightly recurved anteriorly; the sexual aperture of the male lies at the hind end in a sort of cloaca (in which the intestine also ends), and is surrounded by six soft cirri, of which the first two are bifid at the apex, the two next divided into three, and the last simple; there is a single testicle; the oviparous female

* Atti Soc. Ital. Sci. Nat., xxvii. (1884) pp. 42–63 (5 pls.).

is larger; the two ovaries lead into a vagina opening posteriorly, a little in front of the anus.

Count Passerini describes (*a*) the structure of the ova, their division into morulæ, the formation of the gastrula by delamination, the origin of the mesoderm from the proliferation of the endoderm, and the formation of the embryo within the egg-membrane. The larval form differs from the adult in its relatively greater breadth, in its sharply pointed tail, in the non-differentiation of the sex organs, in the relatively longer pharynx, and the absence of the six oral papillæ. The body is well protected by a chitinous coat, and like that of the adult, is striated, less distinctly anteriorly. The lateral canals and their external aperture at the end of the pharynx, are distinctly visible.

The *integument* (*b*) consists (1) of a thin chitinous *cuticle*, continued inwards to line the pharynx, and perhaps further; and (2) of a delicate *epidermis*, in which the cellular structure could not be defined. Both exhibit during life fine transverse striations, due to a sort of permanent contraction of the subdermal muscles. (*c*) Below the epidermis lies a layer of longitudinal *muscles* which have a spindle shape, are drawn out at the ends, and exhibit distinct longitudinal striations, and one or more nuclei. Frequently there is on the inner face of the fibre a non-striated, protoplasmic portion, nucleated and slightly granular. The various special muscles, those protruding and retracting the penis, the *ejaculatores* of the testis, those associated with the abdominal cirri, &c., are then described. (*d*) The muscular, chitin-lined *pharynx* is suddenly constricted in front of the intestine, in such a way that the return of food is impossible. The delicate *intestine*, ending in a cloaca, into which the *vasa deferentia* also open, is lined by a simple epithelium of large polygonal cells. No glands were discovered. The contents consisted of pus globules with fragments of lung parenchyma and tuberculous sarcoma. (*e*) The lateral "*excretory*" *canals* originate in a deep cæcum in the tail region, and end similarly a little in front of the oral papillæ. Where the pharynx joins the intestine the two canals are united by fine ducts, which unite and open externally. Further details as to contents, &c., are communicated. (*f*) Multipolar cells, occurring at both ends of the body, in connection with the papillæ, cirri, &c., are described as *nervous elements*.

The *male reproductive organs* (*g*) are described at considerable length. There is but one large testis, the other having probably atrophied. A seminal duct connects the testis (which occupies a large part of the body) with the penis. The testicular cells are at first pyramidal, and exhibit a delicate apical "rachis," this is afterwards lost, and the cells becoming free are modified into spherical spermatozoa. The penis, which serves to keep the *vas deferens* in connection with the *vulva* during copulation, consists of two elongated, toothed, chitinous bodies (*corpi copulatori*), each of which is muscularly connected with a terminal, recurved, toothed *hook*. The action of the various muscles is noted. The six soft anal cirri also aid in the copulatory act, embracing the posterior part of the body of the

female. They are furnished with nerve-cells, and are probably also tactile. (*h*) The *female reproductive organs* are very well developed. The long ovaries, extending from the pharynx nearly to the hind end of the body, function posteriorly as oviducts, whence the eggs pass through a peculiar muscular collar into the vagina, which s also furnished with delicate muscles. The young ova become fixed by a fine filament (rachis) to a sort of funiculus in the centre of the tube, they liberate themselves from the parietes, lose their rachis, and in the posterior portion of the ovary acquire their chitinous envelope.

Notes on Entozoa.*—M. R. Blanchard reminds us that cysts of *Tænia echinococcus* are not rarely found in the horse, though they are not reported by Dr. Linstow as occurring in that animal. *Amphistoma conicum*, which is known to occur in cows of Europe and Australia, is now reported from Formosa. *Ankylostoma boæ* is a new species from the intestine of a *Boa constrictor;* this is almost the first notice of a nematoid of this genus in an Ophidian, most of them living in warm-blooded animals. *Rictularia bouvieri* is a new species found in the intestine of *Vespertilio murinus*, but is described from a single (female) specimen; this is a very rare generic type, but there is in Dr. Dohrn a sixth observer, not noticed by M. Blanchard, nor is his species (*R. macdonaldi*), from a West African bat, mentioned by the author in his synopsis or synonymy.

Anatomy of Tænia lineata.†—Dr. O. Hamann gives a detailed account of this parasite of the dog; the ripe proglottis is remarkable for containing a rounded body, from which a much-coiled tube is given off; the body has a reddish colour, and, with the tube, is filled with embryos. After the joints have been deposited for two or three days the embryos are found in the spherical body only.

The musculature is of a somewhat abnormal type, and may be arranged in two groups; in one we have the fibres in which the formative cells are retained, and in the other no remnants of these cells at all. In the first group we find the circular layer and the dorso-ventral muscles; on each fibre of the latter there is a large peripheral cell, which seen from the surface is oval or spindle-shaped in form; when seen from the side the connection between the cell and the fibre can be made out. In the second group are the fibres which lie parallel to the long axis of the proglottis, the subcuticular longitudinal muscles, and the layer which surrounds the centrally placed organs. The characters of the longitudinal trunks of the water-vascular system vary considerably in different proglottids; the trunks are lined by a fine hyaline membrane, secreted by flattened epithelial cells; from the trunks there are given off fine canals, which can be followed for some distance; they terminate in a funnel-shaped widened end; the course of the fine vessels is exceedingly irregular, they are much coiled and often branch; each lateral twig ends in a funnel; they are transparent tubules of 0·00142 mm. diameter;

* Bull. Soc. Zool. France, xi. (1886) pp. 294–304 (1 pl.).
† Zeitschr. f. Wiss. Zool., xlii. (1885) pp. 718–44 (2 pls.).

below the funnel is a vesicular structure which partly projects into it. The funnels are often pretty close together.

The generative organs are represented by a spherical body which lies at the hinder end of the proglottis, and gives off posteriorly a short tube, and anteriorly a longer one, which may be several times coiled; this last is the uterus; the spherical body is to be regarded as the shell-gland. The uterus is invested in a hyaline membrane formed by a cell-layer; the epithelium ceases where the uterus passes into the shell-gland; between the ova there is a ground-substance, in which the eggs lie; in very thin sections this substance is seen to form a fine plexus, in which amœboid cells are imbedded; these appear to be unfertilized germ-cells. The vas deferens has its loops turned towards the dorsal surface. The vagina opens beneath the cirrus, and the orifices are (and this is important) on the flat surface of the body, not marginal.

The author points out the differences between this species and the *Tænia* of man—they lie in the form of the oviform organ which he regards as representing the complex of gland-cells, which in other *Tæniæ* form the shell-gland; the position of the orifices, and the fact that the vaginal orifice lies above instead of below that of the cirrus; the uterus recalls that of *Bothriocephalus*, as do too the forms of the eggs. The statements of Griesbach as to the tissues of Cestoda, of Salensky as to the musculature, and of Pintner as to the water-vascular system are examined and compared with the author's results.

In conclusion the author raises the questions, firstly, does the position of the generative orifices form a sufficient reason for establishing a new family for the reception of this species? and comes to the conclusion that it does not; secondly, does the fact that the uterus is coiled, instead of consisting of a median trunk with lateral branches, justify the formation of a new genus? the answer to this is in the affirmative, and the name of *Ptychophysa* is suggested. The forms, already described by previous writers as *Tænia lineata*, are, in the last place, examined.

Genital Organs of Pontobdella muricata.*—M. G. Dutilleul reminds us that the male orifice of the hermaphrodite *Pontobdella* is large, and surrounded by a folded welt, and that the female orifice is small and not so surrounded. The male apparatus consists of testicles, deferent canal, seminal vesicle, efferent canal, and spermatophore-pouch. There are six pairs of white ovoid testicles, which decrease in size from before backwards; each is placed in a pouch formed by the dorso-ventral muscles, and consists of a poorly developed muscular investment, which is lined by the male epithelium; the canal from each testicle opens into a common duct which leads to the seminal vesicle. Below the sixth testicle it continues its course parallel to the seminal vesicle, then curves on itself at the level of the point of union of the vesicle with the efferent canal, forms a descending spiral, and opens at its base. This arrangement reminds us of what Quatre-

* Bull. Sci. Dép. Nord, vii. and viii. (1884–5) pp. 349–54; ix. (1886) pp. 125–30 (1 pl.).

fages saw in *Branchellion*, and may be regarded as being the origin of the more complex arrangement which is seen in the higher Hirudinea. The seminal vesicle is large, and of a white colour; its efferent canal is more resistant in structure, and is so folded on itself as to take the form of a reversed U; the ascending is more muscular and less glandular than the descending branch, and has a much wider lumen; the descending branch enters into relation with the efferent canal.

The spermatophore pouch is ovoid in form, and soft; that of either side unites with its fellow by a short canal which opens at the male orifice; it is essentially formed of long unicellular glands, surrounded by a common muscular investment; the short connecting canal is formed by the invagination of the integument at the level of the male orifice.

The female apparatus consists of two ovaries, two oviducts, and two accessory glands; the ovaries are tubular, and often rolled round the vesicles, sometimes even round the nerve chain; their wall is delicate and transparent, and contains two planes of muscular fibres; the oviducts are merely prolongations of the ovaries; the accessory glands give off two or three canaliculi which open into the canal which is formed by the fusion of the two oviducts; they are soft, and contain a reticulum of muscular and connective tissue in which unicellular glands are imbedded; they are invested in a muscular sheath, by which they are, so far, distinguished from the Platyhelminthes.

The general disposition of the genital apparatus recalls that of *Branchellion* and *Batrachobdella*, with which *Pontobdella* agrees in all essential points.

Turbellaria of Lesina.*—In a preliminary communication Prof. L. v. Graff gives an account of a few species. The acœlous form which in 1874 he called *Convoluta cinerea* he now calls *Cyrtomorpha cinerea*; it is very common at Lesina; the mouth is in front of and not behind the otoliths, the generative orifices are separate, and the penis is a conical protrusible papilla; the female orifice is fringed by powerful cilia; the otolith is imbedded in a protoplasmic process arising from the wall of its vesicle. *Enterostoma Zooxanthella* n. sp. is one of the smallest of the Turbellaria of Lesina; it is scarcely half a millimetre long; its dirty yellow colour is due partly to a brownish reticular pigment of the parenchyma, and partly to the zooxanthellæ which are found in its enteric cells, each of which ordinarily contains one to three spherical parasitic algæ 0·007–0·009 mm. broad. This is the only known turbellarian in which zooxanthellæ are found in the enteric cells, and which so far agrees with the Actiniæ; *Enterostoma* has large pseudorhabdites in its integument, and four black eyes; it is extraordinarily sensitive to light. In the body-cavity of one individual there was found a young sexless *Distomum*.

Anatomy and Histology of Myzostomida.†—Mr. F. Nausen has examined a few species of *Myzostoma*, of which *M. giganteum* and *M.*

* Zool. Anzeig., ix. (1886) pp. 338–42.

† 'Bidrag til Myzostomernes Anatomi og Histologi,' 4to, Bergen, 1885, 80 pp. (9 pls.); English résumé, pp. 69–80.

graffi are new species, both taken from *Antedon celtica*. *M. giganteum* is very like *M. gigas*, but has a more robust and less flattened body; *M. graffi* is like *M. marginatum*, but is distinguished by its "tongue-indented margin," and by the twenty cirri, one on each of the twenty tongues of the margin. The nervous system is altogether on the annelid and arthropod type, appears to be greatly differentiated, and to lie at some distance from the surface, the ventral cord being separated by a thick muscular layer from the ectoderm. The cerebral ganglion has no special sheath, but the circular commissures have a double neurilemma-sheath. The proboscidial nervous system is well developed, three pairs of nerves arising from the œsophageal ring and connecting it with the tentacular nerve-ring in the proboscis. The ventral cord is oblong, short, and concentrated, has a double nerve-sheath, and an intermediate nerve passing between the two longitudinal commissures; this communicates with the commissures by alternating branches. Eleven pairs of nerves issue from the ventral cord, five of which are larger than the other six: to Mr. Nansen the segmentation of the cord is not as obvious as it was to Mr. Beard.

There is some difficulty in determining whether the so-called parapodial ganglia are really nervous, and not glandular in nature. In *M. giganteum* they were found to consist of two ganglia containing a large number of cells; these are multipolar, and each sends a prolongation towards the external extremity of the parapodium. In *M. graffi* the two ganglia of each parapodium are united, and contain a few (six to seven) gigantic cells. At the inferior extremity of the ganglion there is a peculiar organ which has the form of a glass bulb-receiver with the long receiver-neck passing towards the extremity of the parapodium; the globular portion consists of several concentric layers, within which there is a substance which appears to be coagulated.

The outer neurilemma-sheath consists of a stout homogeneous membrane which stains deeply; no nuclei were found in it, but many were seen adhering to its outer side; it is probably a cuticle, and is derived from the adjacent layers of connective tissue; it gives off septa which pass into the inner neurilemma by the inner parts of the ventral nerve-cord. The inner neurilemma-sheath is formed of reticulating layers of connective tissue, which form membranes for the fibrillar cords and the ganglionic cells. These last are mostly unipolar; the prolongations from them either pass directly into a peripheral nerve to form a nerve-tube, corresponding to the cylinder-axis of vertebrates, or they become broken up into the fibrillar reticulation of the central mass, from which nerve-tubes arise. In section, the protoplasm of the ganglion-cells always appear to be spongy. Direct division of the nuclei has been often observed in the ganglionic cells, but in no case karyokinesis. The author doubts the accuracy of Beard's account of the development of the nervous system, and thinks that it is of the type common to Annelids.

There does not appear to be a definite body-cavity, but rudiments of it are apparently to be found in the cavities in which the ova are

situated. The body-parenchyma consists of a reticular nervous tissue, and the size of the meshes varies in different parts of the body.

The nuclei of the muscular fibres are usually situated in protoplasmic prominences at the side of each fibre; the fibres divide at their ends into several branches, between which there are protoplasmic remnants of, probably, connective tissue.

What previous writers have called suckers are really ciliated glandular sacks; their walls are not, as Graff states, muscular, but they are glandular internally, and are covered by a ciliated cuticle, which has a striated appearance owing to the penetration of the cilia into the tissue. They differ from the nephridia of Annelids by not communicating with the body-cavity, but this may be explained by the degeneration or partial disappearance of the body-cavity; their only point of resemblance to the segmental organs described by Huet in Isopods lies in this want of an internal cavity.

The hooks are solid, consisting of an outer homogeneous and an inner fibrous layer. In *M. giganteum* the glandular mass surrounding them is particularly well developed; and its cavity communicates with the sea-water by the canal of the chief hook. The alimentary canal is divisible into the proboscidial canal with the œsophagus, the stomach, the intestinal branches from the stomach, and the rectum with the cloacal canal.

Complemental males were found in *M. giganteum*, *M. gigas*, and *M. carpenteri*; they are quite similar in structure to the hermaphrodites, except that where the latter have ovaries the males have tubes with slightly developed cells, so that they have a certain resemblance to young ovaries; the dorsal oviduct (uterus) is feebly but the lateral oviducts are well developed. The author disagrees with Beard as to the secondary origin of the hermaphroditism of Myzostomida, inasmuch as the dicœcious species are the most parasitic, and the rudiments of testes in *M. cysticolum* appear to be rather remnants of an androgynous stage than budding developments of male organs.

As to the difficult question of the systematic position of the group, the author is of opinion that they are distinct from but allied to Chætopods; while they show a tendency towards certain Arachnids (Linguatulida, Tardigrada, and perhaps Pycnogonida) and Crustaceans. They are sprung from the Trochophora, and, among Archiannelids, are related to *Histriodrilus*.

New Rotifer.*—Under the name of *Stephanops leydigii* Dr. O. Zacharias described a short time ago a new rotifer which has since been independently described by Mr. J. E. Lord. It is almost certain that the species is distinct from the *S. longispinatus* of Tatem.

New Floscule.†—*Floscularia millsii* resembles *Stephanoceros* in its elongated form and very attenuate lobes, as well as in its motion, but Dr. D. S. Kellicott regards it as belonging to the genus *Floscularia* on account of its general structure. The presence of a single

* Zool. Anzeig., ix. (1886) pp. 318–20.

† Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 48–50 (1 fig.).

eye instead of two might warrant its place with *Stephanoceros*, but the arrangement of the cilia on the arms does not agree with that genus. So far it has only been found in Black Creek, Ontario, attached to *Utricularia vulgaris*. The gelatinous, sub-cylindrical sheaths of *F. millsii* are usually attached in the upper axil of a branch or leaf; it is usually solitary. The peduncle is short; the posterior attenuate; the muscular part is long, and terminates in the broadly ovate body. The large mouth-funnel is but little broader at its free edge than below; the edge of the mouth is drawn out into fine, very long, flexible, trochal lobes, which are without the slightest knob-like enlargement at the extremity. One to three eggs are to be seen in the tube; but the author did not watch them till they were hatched, and therefore was unable to determine certainly as to which genus the animal should be referred.

Echinodermata.

Development of Comatula mediterranea.*—M. J. Barrois finds that the true blastopore of *Comatula* has nothing in common with what is ordinarily regarded as such; it closes before the end of development and at the time when the cells of the mesenchym are being formed at the expense of the endoderm. Immediately after its closure the endodermic vesicle is constricted into two parts; the two peritoneal sacs which are formed from the hinder portion do not change their places, but are transformed into two discs which unite around the intestine; these discs do not extend beyond the organ, and give off no prolongations either backwards or forwards; the cord which is found in the stalk of the young pentacrinoid larva is formed exclusively from the mesenchym. The vestibule or tentacular chamber is formed at the expense of the so-called blastopore; this last is not an orifice destined to disappear, but a pit which appears late. When the larva becomes fixed this pit deepens, and gives rise by invagination to an entirely closed sac which makes its way between the ambulacral ring and the portion of the ectoderm which will form the dome of the calyx; here, as in *Synapta*, there is a displacement of the larval mouth, while the pit and the blastopore are the homologues of the mouth and anus of other larval echinoderms.

Nerve-terminations, Sense-organs, and Glands in the Pedicellariæ of Echinids.†—Dr. O. Hamann has found and traced nerves in the various pedicellariæ—buccal, trifoliate, tridactyle, and gemmiform—in several species of Echinids; and finds that from the main nerves branches are given off to sense-organs and glandular sacs. These sense-organs are elevations on the inner face of the valves of the pedicellariæ in *Echinus acutus;* there are two such sense-elevations on each tube in the gemmiform pedicellariæ. In *Strongylocentrotus lividus* there is only one sense-elevation.

In *Sphærechinus granularis* there are three elevations near the

* Comptes Rendus, cii. (1886) pp. 1176–7.

† Ann. and Mag. Nat. Hist., xvii. (1886) pp. 469–72; from SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1886.

base, and from them spring projections having the structure of the gustatory papillæ of vertebrates. In the tridactyle and buccal pedicellariæ the sense-cells are not collected into a sense-organ, but are scattered over the surface; and there are numerous nerve-fibrils running to the epithelium. The nerve-stems consist of fibres and ganglion-cells, which are more numerous at the point of branching of the nerves.

In the gemmiform pedicellariæ the valves contain one or two glandular sacs, with muscular walls, opening at the apex of the valve. All the pedicellariæ are tactile organs, as the nerve-terminations indicate; the trifoliate ones seem to remove sand and protozoa, &c., from the test. The larger pedicellariæ serve to keep off larger living bodies, e. g. worms, and therefore act as weapons, as well as for organs of attachment when the animal is moving about.

In *E. microtuberculatus* the gemmiform gland-bearing pedicellariæ hold fast seaweeds, &c., when the animal is at rest; these help to hide it, and the secretion from the glands is therefore of the greatest service.

Striated Muscles in the Echinida.*—In reference to Dr. O. Hamann's description of the striated muscles in Echinids, Mr. F. E. Beddard draws attention to his own previous discovery of these muscles in 1881, in *Echinus sphæra*. Since then Mr. Beddard has found similar muscles in the pedicellariæ of *E. melo* and *E. brevispinosus*, *Toxopneustes lividus*, and in a species of *Arbacia*. He was unable to find these elements in the Echinids from the 'Challenger,' probably owing to their bad state of preservation.

He has also found, in the above species, the peculiar structures described by him and Mr. Geddes in *E. sphæra;* these have the form of flat plates of elastic tissue, in connection with the pedicellariæ.

Development of Ophiopholis and Echinarachnius.†—Mr. J. Walter Fewkes finds that the larva of *Ophiopholis aculeata* passes through a pluteus-stage; the egg-cleavage is similar to that of other Echinoderms; a gastrula is formed by the invagination of the blastoderm, and consequently the stomach of the pluteus is an infolded wall of the blastoderm, and is not formed by delamination from the cells in the cavity; the mesoderm cells originate in two lateral clusters. The egg of *Echinarachnius*, which can be artificially fertilized, segments in the same way as that of other Echinoderms; it has no polar globules, while the egg is free in the water. As in some other Echinoderms the gastrula is formed by invagination; the pluteus referred to *Echinarachnius* by A. Agassiz is an immature pluteus. The mode of development of the young on the water-tube of the pluteus resembles that of other Echinoids, and there is the same rosette form of the water-tubes. The first formed calcareous deposits of the test are trifid in shape and vary in number in different specimens. The extremity of each trifid division bifurcates later

* Ann. and Mag. Nat. Hist., xvii. (1886) pp. 428–30.
† Bull. Mus. Comp. Zool., xii. (1886) pp. 105–52 (8 pls.).

on, and the calcareous body thus formed appears to be enclosed in a transparent wall, which has a spherical outline. Spines are very early formed, and as in other Echinoderms are proportionately very large, as compared with those of the adult.

Organization of Star-fishes.*—Prof. E. Perrier discovered in the collections from Cape Horn a new incubating star-fish, to which he gives the name of *Asterias hyadesi;* the young were found to be attached to the mother by a sort of lateral cord, which was interradial in position, and was formed by a prolongation of the buccal membrane. The youngest individuals were 2 mm. in diameter, and on their disc there were three calcareous pieces; M. Perrier thinks that this shows the incorrectness of the opinion of Messrs. Sladen and Carpenter that the ten primitive pieces of young asterids remain on the disc. The "nervous layer" was found to be very poor in cells and to be nothing but a supporting membrane traversed throughout its thickness by a number of fibres; these end in certain cells of the external epithelium on the one hand, and on the other in the cells which have been considered as forming the internal epithelial layer; these cells are multipolar; towards the end of the arm they cease to form a simple epithelial investment, and are supported by transverse trabeculæ which put them into relation with the cells of the sensory pits which are ordinarily regarded as eyes. These then are the nerve-cells, while the epithelial cells with which they are united across the supporting layer, ordinarily regarded as the true nervous system, are the sensory cells of the epithelium.

On the wall of the sacciform canal which surrounds the hydrophoral tube there is attached a problematic organ which is prolonged beyond the sacciform canal, in such a way as to form two organs connected with the intestine, and giving off two lateral branches which are in indirect relation with the genital glands. This problematic organ, which has lately been called the chromatogenous organ by Hamann, has in young *Asterias hyadesi* the form of a lateral conical prolongation of the peritoneal membrane of the digestive sac, and it contains a large number of vitelline bodies identical with those of the wall of the sac. The lobes of its surface are continuous with the trabeculæ which form the living basis of the skeleton of the star-fish, and it dilates at its external surface into membranes which envelope the hydrophoral tube. This "collateral organ" of the tube is then not a heart, but the site of the production of elements, some of which, becoming free, form the corpuscles of the general cavity. The canaliculi of the madreporite are due to nothing more than the folding of the walls of the vibratile infundibulum, by which the hydrophoral tube opens to the exterior; M. Perrier is convinced that the tube communicates, at the point where it unites with the apex of the funnel, with the cavity of the sacciform canal. If the canaliculi of the madreporic plate only lead into the hydrophoral tube, or its upper expansion, the tube itself opens into the sacciform canal laterally, and sea water can thus pass into the lacunar spaces which

* Comptes Rendus, cii. (1886) pp. 1146–8.

Hamann considers as a schizocœl, into the subambulacral cavities, and into the general cavity.

In star-fishes, then, as in Echinids and Comatulids, sea water plays an important physiological part, but its course is not regulated by as complicated a system of irrigating canals; this leads to a division of the Echinodermata into two great groups, one of which contains the Cystoidea, Blastoidea, Stellerida, and Ophiurida, and the other the Crinoids, Echinoids, and Holothurians. In this phylum, as in Cœlenterata and sponges, the penetration of water is a general phenomenon, while it is rare in worms, Arthropods, Mollusca, and Vertebrata; we may, therefore, with de Blainville, divide animals into the three great groups of Protozoa, Phytozoa, and Artiozoa.

Vascular System of Spatangus purpureus.*—M. H. Prouho ascribes the difficulties in homologizing the vascular system of Spatangids with that of regular Echinids to the imperfect observation of certain anatomical facts. He finds that the two vascular systems of *Spatangus* are as distinct as in *Echinus*, and their relations are exactly the same. The only difference is that, instead of there being a double Polian ring as in *Cidaris*, there is a double Polian canal. The sand-canal and the ovoid gland have exactly the same relations in *Spatangus* as in the regular forms. What has been called the sand-canal in *Spatangus* is really the homologue of the Polian ring of the Cidaridæ, and it is therefore proposed to call it the Polian canal. The term sand-canal or aquiferous tube must be reserved for the vessel which extends from this double canal to the posterior extremity of the madreporite apophysis.

Cœlenterata.

Origin of Metagenesis in Hydromedusæ.†—Mr. W. K. Brooks considers that the view usually held, viz. that the sessile colony is the primitive form, from which medusæ have been derived by division of labour and the specialization of the reproductive member of a polymorphic hydroid corm, is irreconcilable with the life-history of Narco- and Tracho-medusæ.

In *Liriope* amongst the latter, and in *Æginata* and *Cunina octonaria* amongst the former, a true planula, and a true hydra stage is passed through which developes directly into medusæ. "The life-history of these forms proves conclusively that the medusa stage is older than the sessile hydroid-corm, which has arisen through the power to multiply asexually, which is possessed by the hydroid larva of the medusa."

By means of diagrams the life-history of various types is shown. Commencing with the above simple life-history, through that of *C. parasitica*, in which the actinula, or floating hydra, never becomes a medusa, but buds off hydræ which thus develope, he passes to the still more complicated instance of *Turritopsis*. Here the planula,

* Comptes Rendus, cii. (1886) pp. 1498–1500.

† Johns-Hopkins Univ. Circ., v. (1886) pp. 86–8.

instead of becoming a hydra, becomes a degraded actinula, a mouthless, untentaculated "root"; this gives rise to hydræ, which in turn produce medusa buds. In this form a secondary alternation is thus inserted in the life-history. In *Hydractinia*, owing to polymorphism, and to a much greater extent *Podocoryne*, a still more complicated history is gone through. The "root" buds off nutritive hydræ, each of which buds off three sorts of polyps, one of which, the blastostyle, buds off medusæ, which again bud off other medusæ, which produce eggs. Here several secondary alternations are intercalated. The case of *Hydractinia* is regarded as beginning to simplify its life-history by the degradation of the sexual medusæ into sessile reproductive organs.

The author's theory is that the remote ancestor of the Hydromedusæ was a solitary actinula with no medusa stage, but probably the power of budding. This actinula became more and more adapted to swimming until it became converted into a medusa, developing straight from the egg without alternation of generations. Having reached this stage, the larva acquired the property of fixing itself, and then multiplied by budding off similar larvæ, which became medusæ. This fixed condition having become perpetuated by natural selection, the primary larva ceased to become a medusa, but remained a sessile larva and budded off larvæ which became sexual medusæ. The medusa characteristics of these secondary larvæ became accelerated, and the primary larva acquired the power to produce larvæ which like itself remained sessile. In this way sessile hydra communities with medusa buds and free sexual medusæ were evolved; finally these became polymorphic; and gradually the free medusæ were degraded to medusa-buds or sexual buds on the bodies of the sessile hydras.

Nematocysts in the Siphonophora.*—M. M. Bedot finds in the Velellidæ two sorts of cnidoblasts, provided with stalks ("tiges"), the nematocysts of which are distinguished by the presence or absence of a barb at the base of the thread, as well as by their difference in size. In the large cnidoblasts, muscular striations are seen at the base of the stalk; this also shows at its terminal region a spindle-shaped organ, which encloses a spirally coiled filament and a highly refracting spherical body. The cnidoblasts which are scattered through the ectoderm of the tentacles in the Velellidæ and which are not grouped to form batteries are deprived of stalks and cnidocils.

The Physalidæ also present two forms of nematocysts, neither of which are barbed. On the fishing filaments there is every stage between cnidoblasts with and without a stalk. From this one is led to conclude that the stalk is formed from the cnidoblast itself, and not from a neighbouring cell, as was supposed. The nematocyst arises in the interior of a small spherical cavity, which has become formed in the cnidoblast, and which is filled with a transparent fluid. From the wall of this cavity a small bud or "nematoblast" arises which gradually projects into the fluid. It increases greatly and ultimately nearly

* Arch. Sci. Phys. et Nat., xv. (1886) pp. 415–6.

fills the cavity and is only united to the wall by a narrow stalk. The nematoblast gives rise to the thread; the fluid which surrounds it solidifies and forms the case of the nematocyst. When the thread is barbed its development is more complicated; in the interior of the nematoblast a small sphere appears, this becomes hollow and invaginated, and thus forms the barb.

Stephanotrochus moseleyanus.*—Mr. W. L. Sclater describes a new species of the genus *Stephanotrochus*, which is not only interesting as being the finest and largest of the genus, but as the first recorded from the British seas; it was dredged by H.M.S. 'Triton' at a depth of 570 fathoms in lat. 59° 51′ N. and long. 8° 18′ W.; its nearest allies were taken by the 'Challenger' off the Azores and Pernambuco. It differs from species already described by the greater development of the pali, and the stouter primary and secondary septa, of which there are altogether five complete cycles. The cord presents evidence in favour of Koch's theory that the theca is formed from the fused peripheral ends of the septa; the darkly coloured oral disc, the tentacles, and outer soft wall contains polyperythrin; the tentacles are in four cycles, and those of the innermost are the largest and twelve in number. In the arrangement of the muscles on the mesenteries *Stephanotrochus* exactly corresponds to the Hexactinian type, as do all other madrepores that have yet been studied. The single specimen examined contained ova only, so that the species is probably dioecious. Cells, which appear to be calycoblasts, differ from those described by Koch in having an irregular instead of a quadrangular shape; this may be due to their greater age.

Polyparium ambulans.†—Dr. A. Korotneff describes from the straits near the island of Billiton, a remarkable colony, 7 cm. long by 15 cm. broad, which is bandlike in form, and on one side has the upper sharply separated from the lower surface; on the other side, however, they pass into one another; the anterior is not to be distinguished from the hinder end. The upper surface is covered by peculiar polyps, the base of each of which is much broader than the tip, which carries a round orifice. The polyps appear to be altogether devoid of tentacles; They are not all of the same size, and the smallest, which have no oral orifice, appear to be buds.

The lower surface is covered with suckers, which are very regularly arranged; each row is set transversely, and is separated from its neighbours by a transverse groove; the suckers, like the polyps, vary considerably in size; the whole colony moves like *Cristatella*.

The polyps have no septa, and the internal surface is quite smooth and devoid of the ridges which might indicate an affinity with corals. The lumen of each polyp passes into the spacious lumen of the foot or body of the whole colony; this is broken up by partitions into divisions of equal size, but these partitions are certainly not the homologues of the ordinary septa of polyps; they are set transversely to

* Proc. Zool. Soc., 1886, pp. 128-36 (3 pls.).
† Zool. Anzeig., ix. (1886) pp. 220–4.

the longitudinal axis, and divide the cavity in such a way that every two segments enclose a lumen which opens above and to the exterior by means of the polyps and carries below a row of suckers. Each polyp has a corresponding sucker, and we may, therefore, regard each polyp plus a sucker, as one individual. Each sucker has a retort-shaped cavity which communicates with the lumen of the colony. Typically each polyp resembles an Actinian in minute structure. Cells and fibres unite to form a continuous nervous sheath. The endodermal cells are completely filled with parasitic plant-cells. There are no radial or circular muscular fibres in the suckers, and they repeat the general type of structure, with the exception that glands are developed in them; the septa have a double musculature; when their longitudinal fibres contract the foot with the suckers is withdrawn from the ground, and the transverse row of suckers which correspond to the partition are set free. The transverse system of muscles next contracts, and the whole colony becomes longer along its long axis; in this way the movement of the colony is effected.

Porifera.

Sponge Spicules.*—Prof. W. J. Sollas discusses the possibility of siliceous sponge spicules being transformed into calcareous spicules, as has happened in fossil sponges. He finds the siliceous spicules are composed, not of pure silica, like quartz, but of a colloid variety, combined with organic material. In order to determine the refractive index of these spicules, they should be placed in some fluid in which they become invisible, that is in a fluid of the same refractive index. The fluid in this case was chloroform, the index of which is 1·449; thus these spicules are composed of a substance with very nearly the same index as opal. By this method similar species of minerals can be distinguished when isotropic; and even anisotropic substances can be so distinguished, by using, in conjunction, Nicol's prisms. In the case of fossil calcareous sponges, their preservation or not depends on their being composed of calcite or arragonite or some combination of either with organic substances.

In order to ascertain the specific gravity of sponge spicules, the author adopted a method which is described at p. 879, Vol. V. of this Journal. From his experiments he considers them to be probably calcite in combination with organic matter, their specific gravity being 2·62. The author disputes Häckel's view that regular triradiate spicules have a crystalline form, derived from a regular 12-sided pyramid; he finds that the optic axes of a sagittal spicule and the morphological axis of the unpaired ray are in the same plane, which is a right angle to the plane of the spicule.

From other experiments with crossed nicols he concludes that the acerate is not homologous with the unpaired ray, but with one or both of the paired rays, of a sagittal spicule.

Calcareous spicules, after remaining in Canada balsam for some

* Scientif. Proc. R. Dublin Soc., iv. (1885) pp. 374–92 (1 pl. and 7 figs.).

years, were found to be etched with striæ, ending in edges transverse to them; and near the apex of a spicule the projecting angles of crystals are seen. In the case of sagittal spicules the paired rays are etched, the unpaired is not affected. The author was able to produce the etching, at will, by means of acetic acid. In section acerates are oval or rhomboidal, and this serves to distinguish calcareous from siliceous spicules. This fact is an argument in favour of Prof. Sollas's opinion that the Pharetrones are of a calcareous nature. He concludes that the acerates of Calcispongiæ are built up of excessively elongated primitive rhombohedrons of calcite.

The perforate Foraminifera consist of calcite, judging from their specific gravity; whilst the Imperforata consist either of arragonite, or if of calcite, this must be in combination with phosphate of lime, or carbonate of iron.

Artificial deposition of Crystals of Calcite on Spicules of Calcisponge.*—Prof. W. J. Sollas mentions the finding of sponge spicules incrusted with crystals of calcite, after standing for some days in water containing an excess of calcium carbonate. They appeared to have their optic axes orientated similarly to the calcite of the spicule.

In a sagittal triradiate the crystals are confined to opposite sides of the paired ray, and to the extremity of the unpaired ray. In an acerate opposite sides for the whole length were incrusted; thus the crystals are deposited on the parts showing greatest liability to solution, and the polarity which leads to solution appears to determine deposition.

Sponges of Bohemia.†—Herr P. Frantisék gives an account of various sponges. The first is *Carterius stefanowii*, which varies in size, but may be 10 cm. long and 3 cm. broad; the spicules are ordinarily quite smooth and sharp at their tips; the gemmules are spherical or ellipsoidal, and have a high upper pole. The germ is protected by an internal chitinous membrane, from which arises a cylindrical or conical air-tube; at its end there is a delicate crown-like appendage. The inner membrane is covered by an air-chamber-layer, which consists of small polygonal chambers, which are normally filled with air. The amphidiscs are very numerous, and are provided with a number of spines; they are of two lengths, the longer of which, with the crown at the upper end of the air-tube, forms an apparatus by means of which the gemmules can attach themselves to foreign bodies, and so be carried from place to place. This species was first found in Russia by Dybowski, who, with a query, called it *Dossilia stefanowii*.

Ephydatia bohemica n. sp. is found with *Euspongilla lacustris*; it is closely allied to *C. stefanowii*, but the gemmules have no air-tube, and the amphidiscs are all of the same length. The author has notes on *Spongilla fragilis*, *Ephydatia muelleri*, and *Euspongilla jordanensis*.

* Scientif. Proc. R. Dublin Soc., v. (1886) p. 73.

† SB. K. Böhm. Ges. Wiss., 1886, pp. 147–74—German abstract, pp. 169–74 (1 pl.).

Classification of Sponges.*—Prof. W. J. Sollas gives the following classification of the *phylum* Porifera :—

Class I. Plethospongiæ.
- Sub-class 1. Hexactinellida.
  - Order 1. Lyssakina.
  - Order 2. Dictyonina.
- Sub-class 2. Demospongiæ.
  - Tribe *a*. Monaxida.
    - Order 1. Monaxona.
    - Order 2. Ceratosa.
  - Tribe *b*. Tetractinellida.
    - Order 1. Choristida.
    - Order 2. Lithistida.
- Sub-class 3. Myxospongiæ.
  - Order 1. Halisarcosa.
  - Order 2. Chondrosiosa.

Class II. Calcispongiæ.

Protozoa.

Physiology and Biology of Protozoa.†—Dr. A. Gruber gives an account of his observations on artificial divisibility and regeneration in Protozoa. He has chiefly made use of the large *Stentor cæruleus ;* here, as in *Oxytricha*, the anterior end replaces the lost posterior end, and the right side the lost left side, and *vice versâ*. He finds that the regeneration of the organula follows the same course as their new formation in spontaneous fission. The unknown impulse which induces the animals to divide, and the irritation caused by the violent removal of a part of the body, are identical in their effects. If we ascribe regeneration in the Metazoa to the influence of embryonally formed cells, we must in the Protozoa ascribe the function of new formative elements to originally formed elementary particles ("micellæ") which are subject to the directing influence of the nucleus. Regeneration is due only to a conversion of elementary parts already present, and is set up by external irritation ; it takes place rapidly, and in the *Stentor* is very powerful ; no particular part of the body appears to be specially disposed thereto, but all parts react in the same way.

The author relates experiments which justify these conclusions, and next describes others which show that two artificially produced halves are able to increase spontaneously at exactly the same time, although after section they were apparently not equivalent ; thus, in one case, the anterior portion which still possessed the peristomial area, mouth, and œsophagus had only to go through the process of wound-healing, while the posterior portion had to produce all the organs anew ; the latter was, nevertheless, able to answer to the impulse just as quickly as the former. This observation shows also that the material for new formations in the Infusoria is not stored

* Scientif. Proc. R. Dublin Soc., v. (1885) p. 112.

† Ber. Naturf. Ges. zu Freiburg i. B., i. (1886) Heft 2 ; translated Ann. and Mag. Nat. Hist., xvii. (1886) pp. 473–94.

up as such, but that the primitive elementary parts are convertible at any time. Other infusorians did not give as striking results as *Stentor cæruleus*, but Dr. Gruber thinks that the difference depends on the greater or less faculty of existing under conditions which are not quite natural, and that the power of replacing lost parts is proper to all Protozoa. This remarkable acquisition of the regenerative faculty may depend on the fact that Protozoa frequently break up spontaneously into irregular fragments, and that many of these fragments are capable of again being developed into normal animals.

The author next proceeds to discuss the significance of the nucleus in regeneration; the want of the nucleus brings about an incapacity to replace lost parts, or produce new structures, and it is clear that the nucleus is the most important, and the species-preservative constituent of the cell, and to it we justly ascribe the highest importance in the processes of fecundation and inheritance. A study of *Amœba binucleata* showed that though the chromatic substance of the nuclei varies considerably in form and arrangement, the true nuclei of any one specimen always agree; this seems to show that the chromatin in the nucleus is an important factor and is not merely an accumulation of nutritive material.

The observation of the phenomena of spontaneous division led to the discovery of certain small differences between the daughter-individuals, and this appears to indicate that the morphological and physiological congruency of the two daughter-individuals produced by division is by no means quite absolute. In *Stentor* division ordinarily took place at intervals of two days, and the presence or absence of nutrient material had no influence on the time of the division. Of this spontaneous division two kinds may be distinguished among Infusoria; one occurs when the individual has grown to a certain size which cannot be exceeded; the other is by divisions following on one another rapidly, and in definite intervals of time, without intervening growth; this, of course, is combined with continual decrease in the size of the body, and happens when the infusorian is placed under unfavourable conditions, in which it is desirable to rapidly produce a large number of individuals for the preservation of the species. These hurried divisions are succeeded by a period of conjugation.

The behaviour of infusorians during conjugation throws some light on the nature of the nervous elements in the cell; as Gruber has already stated, the two members of a pair *in copulâ* make exactly concordant movements so long as they are still united by a bridge of protoplasm. As a single thread-like bridge of protoplasm suffices to cause the loosely connected pieces to behave as one individual, it is clear that the nervous functions in the infusorial body are not confined to definite courses, and that the exertion of will uniformly governs every protoplasmic element. In other words, the nervous potency of the cell is diffused. The consentaneous action of the individuals of a protozoic colony is due to the fact that they are united to one another by cords of protoplasm. The seat of the diffused nervous potency is chiefly to be sought for in the cortex.

Morphology of Vorticellinæ and allied Ciliata.* — Prof. O. Bütschli discusses the problem of the process of division in the Vorticellinæ, which appears to differ so much from what is found in allied Ciliata; it being, as we know, longitudinal instead of transverse, as it is in most other forms. The suggestion arises that the difference is not real, but is dependent on an incorrect morphological orientation of the Vorticelline body. By the Vorticellinæ the author means the groups which Stein called Vorticellina, Ophrydina, and Urceolarina; they agree with all other ciliates (except the so-called Holotricha) in having an adoral zone of stronger cilia, which, as a rule, follows this course—the mouth is at some distance from the anterior end of the body, is on the aspect which is called ventral, and is frequently somewhat nearer to the left than the right side. From it the zone extends to the left margin of a so-called peristomial area, which generally corresponds to the left margin of the ventral side, as far as the anterior end; if it is well developed, as is generally the case, it bends round to the right, and extends along the right side of the ventral surface, more or less far back. The zone takes a more or less well-marked spiral course which is especially well seen in some Heterotricha (*Stentor* and others). This adoral spiral in the Vorticellina has considerable resemblance to that of a *Stentor*, but is especially distinguished by the fact that it appears to coil to the right and not to the left.

As to the origin of the Vorticellina, Prof. Bütschli thinks it unnecessary to take into consideration the restriction of cilia to the ciliated zone, as he believes that this character has been acquired within the limits of the group. On the other hand, it is quite clear that the fixed have been derived from free-swimming forms. The most primitive forms appear to be the Urceolarina, which have a relatively simple peristomial structure, and among them the genus *Licnophora;* the surface of its attaching disc is in a plane with the peristome; the hinder half of the body appears as a kind of stalk for the disc. It seems to Prof. Bütschli that this form can without difficulty be derived from the other Ciliata, whether hypo- or heterotrichous. From an ectoparasitic infusorian, provided with a mouth-spiral, which moves about by its ventral surface on the integument of the animal on which it dwells, *Licnophora* may be derived by supposing that the ciliation became specialized into the ciliated circlet. The hinder part of the ventral surface gradually developed into a special disc of attachment, whereby the anterior part of the body, with the spiral and the mouth, became emancipated from their inferior position; the mode of life of *Kerona polyporum* shows that this is not a fanciful sketch.

If the author's views are correct, the so-called ciliated organ of the Vorticellinæ must be regarded as the dorsal side, and all the rest of the body as ventral; in this case the point from which the stalk of the fixed forms arises must be regarded as the middle point of the ventral surface. With this new orientation we are able to explain

* Morphol. Jahrb., xi. (1886) pp. 553–65.

the apparently anomalous manner of division in the Vorticellinæ. The author gives an account of his observations on division, and concludes with some notes on *Lagenophrys*, in which Stein reported that fission was in an oblique direction. Prof. Bütschli suggests that this appearance is due to the abnormal course taken by the adoral spiral.

Species of Chromulina as Stages of Palmella.*—Herr N. Wille describes the life-history of *Chrysopyxis* which, when it begins its spring vegetation, leaves the thick membrane which invests the encysted cell, and multiplies by transverse division within a mucous covering; while the cells are still within this coat the cilia may be seen to be moving; at the anterior end of the body there is a contractile vacuole. A species of *Chromophyton* is next described, which has oviform swarm-spores, and appears to develope into an *Epipyxis;* they may be easily distinguished from *Chrysopyxis* by having their contractile vacuole in the centre of the cell. The mode of development of these two forms is so similar to that of a *Dinobryon* that the author thinks they must be placed in the same family; and he is further of opinion that the swarm-spores of *Chrysopyxis* are identical with the round form of *Chromophyton Rosanoffii* and *Monas ochracea*, and that those of *Dinobryon* (*Epipyxis*) are the same as the oviform stages of *C. Rosanoffii* and *Monas flavicans;* their reported presence in the same waters justifies this view.

Microscopic Pelagic Animals of the Mediterranean.†—Dr. O. E. Imhof describes a new species of *Cyttarocylis*—*C. adriatica*—the test of which has the form of a stalked cup, the stalk, however, not serving as part of the habitation. A species of *Codonella* was found near Brindisi which resembles *C. acuminata* of the Lake of Como, but differs in size—the whole length was 0·176 mm.

New Fresh-water Infusoria.‡—Dr. A. C. Stokes adds several new species to his former contributions.

Physomonas elongata differs from previous species in the absence of the subspherical outline usually considered characteristic of the genus. A pedicle is formed temporarily, though the animal is usually free-swimming. Reproduction takes place by longitudinal fission.

Tetramitus variabilis is noticeable for the entire absence of the longitudinal grooves found in the other species. *Urceolus subulosus* has a cuticular investment of sand, which is apparently unique among Infusorians. This obscures the internal structure.

Chrysopyxis triangularis, *C. macrotrachela*, and *C. ampullacea* have forms signified by the names given to them. *Prorodon limnetis* differs from *P. teres*, which it most nearly approaches, in the excentric position of the mouth, and the well-marked anterolateral curvature.

Trachelophyllum clavatum is the only species which possesses a *single* nucleus.

* Bot. Centralbl, xxiii. (1885) pp. 258–63.
† Zool. Anzeig., ix. (1886) pp. 198–200.
‡ Amer. Mon. Micr. Journ., vii. (1886) pp. 81–6 (18 figs.).

Perispira strophosoma bears a ciliated ridge-like spiral elevation across the anterior part of body. *Lacrymaria teres* differs from *L. truncata* chiefly in the possession of complex contractile vacuoles, of which there are two spherical ones, connected by a narrow tortuous canal; also in the absence of the convoluted nucleus.

Leucophrys curvilata contains no chlorophyll found in *L. emarginata* Stokes.

Strombidinopsis acuminata has at the posterior end of the body a pointed process; the anterior ciliary wreath is circular.

Vorticella floridensis has a campanulate body which can change its form by elongation or compression.

Cothurnia canthocampi differs from *C. astaci* in the absence of the eversion of the anterior border, and in the very short distance to which the expanded zooid extends beyond the lorica.

Fresh-water Infusoria.*—Referring to the encystment of Rotifers during the slow drying up of ponds, merely for protection, Dr. D. S. Kellicott remarks that the same "protective" encystment in Infusoria must not be confounded with "duplicative" or with "sporular" encystment, previous to fission or to division into spores. The author considers that *Vorticella brevistyla* d'Udekem, *V. rhabdostyloides* Kell., are synonymous with *Spastostyla sertularium*. Geza Enty formed the genus for Vorticellids in which the upper part of the stalk is flexible. The cyst of the species is oval.

Amphileptus meleagris forms its cyst upon the stalk of *Opercularia nutans* after devouring it; and he also found numerous cysts on the thick pedicels of *O. rugosa*. While encysted *Amphileptus* divides into two bodies, which escape as ciliated forms, similar to but smaller than the parent.

He notices the internal budding of *Podophrya quadripartita*, but was unable to confirm Bütschli's account of the change in the nucleus from a granular to a fibrillated condition.

In another communication † Dr. Kellicott mentions the peculiar Vorticellid *Epistylis ophidioidea* in which, besides the ordinary individuals, there are, in a colony, a few elongated snakelike forms, which he regards as having some relation to reproduction. This species has been recently taken in the deep water of Niagara. Amongst the Tentaculifera, the following new forms are described:—

Acineta cuspidata has a spheroidal body which does not quite fill the shortly-pedunculated lorica. There are only a few tentacles, which are long, flexible, and slightly thickened at the extremity. The edge of the lorica is raised up into a point on each side between the two groups of tentacles. This species is closely allied to the marine *A. dibdalteria*.

A. flava has a triangular compressed lorica, with a slender pedicle, which is flexible just below the lorica. The body is not adherent. The tentacles are few, short and distinctly capitate.

* The Microscope, vi. (1886) pp. 53–8 (4 figs.).

† Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 38–47 (1 pl.).

The colour is usually yellowish-brown when the animal is attached to *Stephanodiscus niagaræ*, but sometimes green, when on *Cladophora glomerata;* this latter condition is regarded as a young stage. In *Podophrya diaptomi* the body is pyriform, elongate, with transparent protoplasm, the granules in which are larger anteriorly than posteriorly. The numerous tentacles are not distinctly capitate and are arranged in three fascicles. The nucleus is spheroidal. The young are nearly spherical and the tentacles are then arranged irregularly. The animal is usually attached to the under side of the body-rings of its host, *Diaptomus* sp. *Platycola intermedia* is now regarded by the author as a species distinct from *P. longicollis* with which he previously placed it as a variety; his reasons are founded on the shorter and not funnel-shaped neck.

Amongst the Ciliata he describes as new species:—*Epistylis cambari*, which is found on the gills of various species of *Cambarus* in Niagara river. The body is broadest in the middle and somewhat attenuate posteriorly. The disc is narrow, the peristome thickened. The stout pedicle is bent in large colonies, and usually branches on one side only. By the shape of its disc it is allied to *Umbilicata*, but the different form of the body and pedicle clearly separate them.

Vorticella rhabdostyloides has a nearly globular body, peristome thickened, nucleus thick and but slightly curved. This species was found plentifully in Niagara, attached to *Stephanodiscus Niagaræ* and other diatoms.

Gerda sigmoides was usually found in pairs; the body is very flexible; the posterior tapers nearly to a point, the anterior is gracefully curved.

Mesodinium recurvum has a globose body, with only a short snout-like process. At about one-third the length of the body is a girdle of cilia bent backwards; above this is a wreath of long cilia. It closely resembles *Halteria volvox* in its jumping action.

Strombidium oblongum, and *Trachelomonas torta*, are other new forms described.

A new genus, *Diplostyla*, is formed from a species, *D. inhæsa*, found in swamp water among algæ at Point Abino, Ontario. It inhabits an ovate membranous tube, open at both ends; the body does not protrude, but water passing through the tube carries the food to the animal, and in this seems to resemble *Oxytricha tubicola*. The body cilia are fine and long; mouth behind the centre of the body; undulating membrane long; adoral cilia stronger than body cilia; posteriorly some setose cilia; budding was observed.

Parasites of the Blood.* — Prof. B. Danilewsky describes a number of Hæmatozoa observed by him during his study of blood-parasites. With the exception of *Bacteria* and Vermes the parasites probably all belong either to the Sporozoa or to the Flagellata. As to their entrance into the vascular system, Prof. Danilewsky supports the theory that an important part in the transport (from the ali-

* Biol. Centralbl., v. (1885) pp. 529–37.

mentary canal to the blood-vessels) is played by the leucocytes, an hypothesis confirmed by the occurrence of Hæmocytozoa or parasites within the red blood-corpuscles, while within the leucocytes bodies are not unfrequently observed which resemble parasitic germs.

I. *Trypanosoma sanguinis* Gruby. This Flagellate was found in as many as six varieties in the blood of frogs and fishes. The characteristic undulating hyaline membrane, prolonged into a flagellum, displayed various degrees of differentiation. All *Trypanosoma* species exhibit screw-like undulating movements and contractions. In the frog the following four varieties are distinguishable: (1) the simple membranous form, in which the flat extremely mobile body passes without visible boundary into the membrane; (2) the rolled-up form, having a filter-like shape, resulting from the helicoid twisting of the body on its transverse axis; the undulating membrane extends along the superior broader margin; (3) the "flat-spiral" form, having a somewhat compressed long conical body, pointed posteriorly and spirally twisted; the undulating membrane only along the anterior broader flattened end; (4) the "comb-like spiral" form, twisted in a more or less complete longitudinal spiral, with the surface of the pear-shaped body like a *Pecten* shell; the narrow, well-differentiated undulating membrane along one margin or in the cleft between the two approximated margins. If the two margins of the leaf-like body are fused there is, of course, no cleft; the membrane arises from the anterior broad end, and a most beautiful "cornucopia" form results.

These varieties of *Trypanosoma* (Undulo-Flagellata) were not observed to pass into one another, though less defined, possibly intermediate forms were seen. In preparations where the blood was at rest, interesting changes of cell-phase were observed; the first form became spherical, the flagellum grew enormously at the expense of the membrane, and was finally broken off, leaving an amœboid mass, which occasionally formed long pseudopodia. (There was thus a passage from the ciliated to the amœboid phase of the "cell-cycle" emphasized by Geddes.) In similar circumstances the third form was observed to retract membrane and flagellum, and to exhibit nuclear division resulting in the formation of a mass of (sixty-four) spores. These became modified into monad-like forms, gradually differentiating, and exhibiting longitudinal fission. A transverse direct division of the first form is also described, and Prof. Danilewsky also observed the formation of buds, without, however, being able to follow out their history.

Trypanosoma piscium is much smaller and rarer than that of the frog, &c., and occurs in two distinct forms: (*a*) simple, narrow, and thread-like, with no undulating membrane distinct from the body, and exhibiting extraordinarily lively movements; (*b*) spindle-shaped, consisting of a more or less stiff body and a relatively narrow membrane, spirally twisted from one end to the other and continued directly into the undulating flagellum.

Prof. Danilewsky notes the highly developed plasticity of these Hæmatozoa, especially of the fourth variety of *T. sanguinis*, which in

artificial cultivations (albuminous solutions, &c.) exhibits manifold variations of form, and often produces numerous mobile processes.

II. *Hæmatozoa of Lizards.* Within the red blood-corpuscles of *Lacerta viridis* three different forms were distinguished: (1) a quiescent worm-like cytozoon, resembling *Hæmogregarina* Step, lying near the nucleus of degenerating corpuscles; (2) a smaller mobile form, within almost normal hæmocytes, and characterized by a number of strongly refracting round granules at each end of the otherwise clear worm-like body; (3) a larger form, with one end distinctly thicker, occurring free in the blood as well as within the corpuscles. These varieties are connected by intermediate forms, and the differences probably depend on age and nutritive conditions.

III. *Hæmatozoa of Birds.* (1) A form resembling *Hæmogregarina*, about the length of a red blood-corpuscle, with a screw-like motion, usually with one end rounded and the other more pointed, and exhibiting a vesicular nucleus within the blueish-grey, homogeneous strongly refracting body, was observed swimming free in the plasma. (2) A second, much longer form very closely resembled *Trypanosoma fusiforme piscium.* (3) A third Hæmatozoon occurs frequently within the red blood-corpuscles as a "pseudovacuole" of variable shape, which increases in size, assumes a spherical form, and causes the disintegration of the hæmocytes. It eventually liberates itself, and is seen rotating rapidly in the plasma by means of its flagellum.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

Plasmolytic Studies of the Membrane of Vacuoles.†—Dr. H. de Vries has made a large number of observations on the nature of the membrane—for which he proposes the term *tonoplast*—which separates a vacuole from the surrounding protoplasm. Coincident results were obtained from a large number of plants, the one best adapted for the purpose being *Spirogyra nitida.* The following is a summary of the more important.

It is universally the case in the vegetable kingdom, and in the most various forms of tissue, that the vacuoles possess a true membrane, which may readily be made visible by the application of a 10 per cent. solution of potassium nitrate with the assistance of eosin; the tonoplast being more resistent to the action of this reagent

* This subdivision contains (1) Cell-structure and Protoplasm (including the Nucleus and Cell-division; (2) Other Cell-contents (including the Cell-sap and Chlorophyll); (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) pp. 465–598 (4 pls.).

than the rest of the protoplasm, and retaining its normal properties for hours, and even days, after the latter has been killed. This property indicates a greater density of its substance. The tonoplast is a sharply defined membrane which detaches itself smoothly from the rest of the protoplasm. Application of 10 per cent. nitrate-solution causes normal plasmolysis; the outer protoplasm loses its tension, and takes the eosin-staining, while the vacuole remains colourless and its tonoplast in a state of tension. In *Spirogyra*-cells the outer protoplasm was commonly ruptured, and, by its contraction, partially or entirely expelled the vacuole. The vacuoles contract into a larger or smaller number of free globular vesicles within the stiffened protoplasm-body.

The tonoplast agrees with the rest of the protoplasm, and especially with the parietal layer, in their most important properties, both in normal physiological functions and in behaviour to plasmolytic and other reagents. It agrees with the parietal layer in being scarcely or not at all permeable, protecting in this way the enclosed portions of the protoplasts. They both excrete certain definite substances from their surface, whether stored up in the solid condition like cellulose, or dissolved in the cell-sap like organic acids. In certain cases, as in plasmodia, and in the central circulating movement, both act as motile organs. It is possible in some cases to press out the vacuoles through small openings in the stiffened protoplasm around them; and they then behave like swarmspores.

When vacuoles are isolated from the surrounding protoplasm, their tonoplasts are from the first permeable for acids and bases, but not for easily diffusible salts like potassium nitrate. But after a vacuole has remained for some days in this solution, it is more or less permeable for sodium chloride and potassium nitrate; and this is the case to a greater degree if it was treated at first with a dilute solution of any poison. All experiments indicate that after the death of the outer protoplasm, the tonoplasts do not become suddenly permeable, but only gradually. This increase of permeability depends therefore on a molecular change, and not on the formation of fissures.

In a criticism on De Vries's paper, Herr W. Pfeffer * agrees in the main with his conclusions; and finds a very serviceable staining reagent for the purpose in a 0·001–·002 per cent. solution of methyl-blue. From a mixture of 1 part of methyl-blue and 10,000,000 parts water, the root-hairs of *Trianea*, *Lemna*, and *Azolla* will, in a few days, absorb the pigment as completely as from a concentrated solution. Methyl-violet is absorbed in the same way, without injury to the currents and other vital phenomena of the protoplasm. Nigrosin and anilin-blue, on the other hand, are not taken up in the same way by the living cell.

Aggregation of Protoplasm in Drosera. †—According to Dr. H. de Vries, the phenomenon described by Darwin as "aggregation of protoplasm" is in reality due to contraction and division of the

* Bot. Ztg., xliv. (1886) pp. 114–25.
† Ibid., pp. 1-11, 17–26, 33–43, 57–64 (1 pl.).

vacuoles. He demonstrated that the vacuoles are enclosed in a definite membrane * by the application of a 10 per cent. solution of potassium nitrate, which kills the rest of the protoplasm without bringing about any change in the membrane of the vacuoles. The "aggregated masses" are in reality vesicles filled by fluid contents, each vesicle being a part of a vacuole with its enclosed cell-sap. The irritation which excites *Drosera* and other insectivorous plants to an increased development of their secretion, brings about peculiar and very active movements in the cells of the tentacles, and of their stalks. These movements consist chiefly of three factors, viz.:—(1) An increased and much more strongly differentiated circulation of the parietal protoplasm; (2) A division of the vacuoles into a larger or smaller number of portions, each of which is enclosed in a part of the original membrane of the vacuole; (3) A very considerable diminution of the volume of these vacuoles, a portion of their mass being expelled through the membrane and collecting between it and the circulating protoplasm. This expelled fluid possesses, at least approximately, the same attractive force for water as the rest, but a different chemical composition, the pigment and certain dissolved albuminous substances not being expelled along with it. These albuminous substances can be separated by means of ammonia salts in the form of a finely granular precipitate, which gradually collects into larger balls, and is at first soft but afterwards harder; but this does not take place in the normal process of aggregation. When the action of the irritant ceases, the cells gradually return to their original condition, the vacuoles again increasing and coalescing.

The observations were made chiefly on the marginal tentacles of the leaves of *Drosera rotundifolia*; also on *D. intermedia* and *spathulata*, and on *Pinguicula vulgaris*. The substance used for exciting the irritation was small particles of white of egg.

Influence of Mechanical Forces on Cell-division, &c.†—According to researches by Herr R. Hoffmann, a unilateral strong positive pressure on the cambium-cells may check or even prevent growth in the direction opposed to the pressure. If the pressure acts obliquely on the dividing cells the rows of cells deviate from their normal position. When the bark-pressure has not only disappeared, but become negative, as in depressions in the surface of the stem where the tension of the bark is uniform, the cell-divisions appear to increase in frequency, young stems becoming cylindrical instead of angular. When a stem is wounded, the normal pressure of the bark is removed from the cambium, causing a stronger growth of the stem in the neighbourhood of the wound; and the cells formed on the margins of wounds are isodiametrical until the normal conditions of pressure are restored. The cause of the lateral growth of cortical cells on a wound is traced in the same way.

* Cf. *supra*, p. 637.

† Hoffmann, R., 'Unters. über die Wirkung mechanischer Kräfte auf die Theilung u. s. w. der Zellen,' 24 pp. (4 pls.), Berlin, 1885. See Bot. Centralbl., xxv. (1886) p. 359.

Chlorophyll-grains and Chromatophores.*—Dr. A. F. W. Schimper publishes a very exhaustive treatise on this subject containing details of fresh observations and a *résumé* of the work of other observers.

The nucleus is wanting in no living vegetable cells, with the doubtful exception of the Schizomycetes; in addition to the nucleus are other protoplasmic structures, known as *chromatophores*, from their capacity of producing pigments. They are formed exclusively from chromatophores previously in existence, never by new formation from the cell-protoplasm. The author has detected these structures in the ovum-cell and embryo-sac of *Hyacinthus non-scriptus*, *Daphne Blagyana*, and *Torenia asiatica*, and in the ovum-cell of *Atrichum undulatum* and *Anthoceros lævis* among Muscineæ. They are always present in growing points. In the lower Algæ there is uniformly in the earlier cells a single large chromatophore in each cell, while the more highly differentiated later cells contain a large number of small chromatophores. The same is the case upwards to the simplest Muscineæ, e. g. *Anthoceros*. The simplest Florideæ—the Bangiaceæ and the true Nemalieæ—have a single chromatophore in each cell. In almost all plants the chromatophores change their form as the plant developes.

In the lower plants, the simpler Chlorophyceæ and the Diatomeæ, the formation of *leucoplasts* is a subsequent process, a transformation of the coloured into a colourless chromatophore, while in the higher plants it is usually the reverse transformation that takes place. The Characeæ are the lowest plants in which the leucoplasts have an important physiological function; in the Muscineæ they play but little part; in the Pteridophyta and Phanerogamia they are much more important. The same is the case with the *chromoplasts*, which occur but rarely in the Chlorophyceæ. The chromoplasts are always formed at the expense of chloroplasts or leucoplasts. For the chromoplasts of the Phæophyceæ the author proposes the term *phæoplasts;* for those of the Florideæ *rhodoplasts.*

With the exception of the Anthoceroteæ, where there is usually a single large chromatophore in each cell, those of the Muscineæ are very small and numerous, disc-shaped or polygonal. The chromatophores of the Pteridophyta do not differ essentially from those of flowering phants. Leucoplasts are found in all those parts of Phanerogams which are completely excluded from light; in many of the parts exposed to light which perform other functions than those of assimilation; and in some saprophytes and parasites.

The simplest chromatophores consist of a colourless protoplasmic substance without any visible internal structure or contents; and this is sometimes the case during the whole of their existence, as with most leucoplasts. But usually the protoplasmic structure or *stroma* produces—mostly in its interior, less often on its surface—structures of various kinds. The chemical nature of the stroma is very little known; the protoplasm of the chromatophores has been termed by Strasburger *chromatoplasm.*

* Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) pp. 1–247 (5 pls.).

The leucoplasts are usually globular quite colourless structures, often considerably more refringent than the surrounding protoplasm. In a number of Angiosperms the chromatophores contain protein-crystals, which are isodiametric, tabular, or prismatic. The chromatophores of many Algæ, and those of *Anthoceros*, contain *pyrenoids*, one or more buried in the matrix of the chromatophore, like nucleoli in the nucleus. Except in *Porphyridium cruentum* (*Palmella cruenta*) they are always colourless, and of a more or less delicate reticulate structure. They are segments of the chromatophores in which a peculiar nuclein-like substance is imbedded; they may increase by division or by new-formation.

In many flowers and fruits the chromoplasts have a crystalline appearance, from containing crystalline substances which are either albuminoids or pigments; or both may occur in the same chromoplast. The two kinds are distinguished by their different colour, their different behaviour to reagents, difference in form and in the degree of double refraction, and by the pigment-crystals being always strongly pleochroitic (not dichroitic). But in most cases the pigment of the chromoplasts is not crystalline; it does not then permeate the protoplasm-strings, but is contained in small vacuoles in a fluid or semi-fluid, or sometimes a solid condition. The chromoplasts are always formed by the transformation of other chromoplasts, either leucoplasts or more often chloroplasts.

Chloroplasts have probably the same structure as chromoplasts; they consist of a colourless stroma with numerous vacuoles filled by a green semi-fluid substance. The chloroplasts of all Pteridophyta and Phanerogamia contain granules, termed by Strasburger *chromatosomes;* these are especially well marked in the prothallia of ferns. The same is the case with all the higher Muscineæ; while in *Anthoceros* and in all Algæ the chloroplasts are of a homogeneous green colour, or only very finely punctated, but not granular. In many green Algæ the pigment is not uniformly distributed, but is chiefly accumulated in the marginal parts of the chromatophores.

It has long been known that in some cases—the cotyledons of Conifers and the fronds of ferns—chlorophyll may be formed quite independently of light; the author believes that this is generally the case with Muscineæ, Characeæ, and Algæ, and partially also with the Pteridophyta. The chlorophyll-pigment is destroyed by intense light.

The chromatophores of flowering plants contain oil; and this occurs in all organs, especially in persistent leaves. The various substances produced from the chromatophores are never products of the cell-protoplasm or nucleus; and the chemical changes which take place in the chromatoplasm are also different from those in the cytoplasm and nucleoplasm. The chlorophyll and starch are produced entirely by the chromatophores.

The chromatophores are invariably enclosed in at least a thin coating of protoplasm. The arrangement of the chromatophores in the cell is sometimes altogether irregular; more often it is constant and in definite relationship to the cell-contents. In cells which do

not assimilate it is probably the nucleus that supplies the material which is subsequently transformed into starch, either from the chromatophores or from the cytoplasm. The chlorophyll-grains may either lie on the cell-walls bounding intercellular spaces—*epistrophe*, or on those bounding other cells—*apostrophe*. Light may cause movement of the chlorophyll-grains in two ways:—either dependent on the structure of the organism, and without reference to the direction of impact of the light—*phototonic*, or resulting entirely from the direction of the rays of light—*phototactic*. The apostrophic or epistrophic arrangement is the result of complicated laws dependent on the action of light; very strong irritation of light causes the chlorophyll-grains to collect into one or two lumps, a phenomenon for which Schimper proposes the term *systrophe*.

The result of a number of observations on this subject leads the author to the conclusion that light causes two quite distinct kinds of movement in the chlorophyll-grains; on the one hand the grains tend to move towards certain definite parts of the cell, varying according to the intensity of the light:—phototonic movements; on the other hand to place their broad surfaces parallel or vertical to the direction of the rays of light:—phototactic movements. The phototonic movements are identical with those caused by a decrease in the intensity of the light, by cold, and other sources of irritation; this identity depending on a specific energy of irritation. Movements of the phototactic description are, on the other hand, not produced by any other factor except light.

Formation of Starch-grains in leaves from Sugar, Mannite, and Glycerin.*—Herr A. Meyer shows that the leaves are able to form and to store up starch, not only from glucoses and cane-sugar, but also from mannite and glycerin. He concludes that the starch formed in leaves is the last member of a long series of compounds which are successively produced in the assimilating cells out of the carbon of the carbon dioxide of the air and other elements. The intermediate stages are very different in different plants.

By applying Sachs's test for starch to Böhm's method of using sugar-solutions, the author shows that there are leaves which produce starch out of dextrose as well as out of levulose and galactose, if laid for a considerable period in the dark on solutions of these carbohydrates. Other leaves, again, will obtain starch out of only one or two of these carbohydrates; and the plants in the cells of which any one of these kinds of sugar is found are especially capable of obtaining starch out of this particular kind. No plant was found able to form starch out of inosite. From cane-sugar all the leaves examined were able to form starch, also from maltose; but none from milk-sugar or melitose.

From mannite the leaves of all species of Oleaceæ examined which contain this substance were able to produce starch, while negative results were obtained with the leaves of other plants which do not

* Bot. Ztg., xliv. (1886) pp. 81–88, 105–13, 129–37, 145–51. Cf. this Journal, *ante*, p. 101.

contain mannite. Leaves of *Euonymus europæus* produced starch from dulcite, but not from erythrite. Leaves of *Cacalia suaveolens* obtained it readily and in abundance from glycerin. Experiments with trihydmethyls, aldehyd, and organic acids, yielded negative results.

Formation of Starch out of Glycerin.*—In connection with the experiments of A. Meyer † on the formation of starch, M. E. Laurent has proved the formation of starch in completely etiolated potato-shoots out of glycerin, as well as out of saccharose and glucose; negative results were obtained with acetic acid, oxalic acid, tartaric acid, dextrin, and tannin. With a 10 per cent. solution of saccharose, growth continued more than five months, and tubers containing starch were formed in the axils of the leaves; with a 5 per cent. solution of glycerin starch-grains were formed in the parenchyma of the stem up to a considerable height.

Function of Tannin.‡—Dr. M. Westermaier maintains that tannin in the cells of plants is not a mere waste product of excretion, but possesses assimilating functions, connected especially with the formation of albuminoids. By the action for several days of potassium bichromate, he determined its presence in the palisade-cells of the leaves of a number of plants, also in the conducting tissues, such as the parenchymatous sheath which surrounds the conducting bundles, the conducting cells of the assimilating tissue, and in many elements of the xylem and phloem. Both microchemical reactions and analyses show that the autumnal fall of leaves is preceded by a more or less considerable diminution of the amount of tannin in the palisade-cells. If branches are ringed, the leaves above the ring contain more tannin at the end of September than the normal leaves in August. In its appearance and translocation, tannin shows analogies with starch.

Nectar.§—Dr. A. v. Planta finds that the nectar of *Protea mellifera*, evaporated to a syrup, and thus obtained in large quantities from abroad, contains no nitrogenous matter, but 73·17 per cent. of solids, of which 70·08 is grape-sugar, and 1·31 cane-sugar. Grape-sugar was obtained from the syrup in a crystalline form. Besides the sugar, a small amount of formic acid (apparently brought by the bees) and ash was present. The following table gives the percentage of sugar in the fresh nectar of three plants examined:—

	Total Solids.	Total Sugar.	Cane Sugar.	Grape Sugar.
Nectar from *Bignonia radicans* ..	15·30	15·27	0·43	14·84
,, ,, *Protea mellifera* ..	17·66	17·06	0·00	17·06
,, ,, *Hoya carnosa* ..	40·77	40·64	35·65	4·99

Aqueous extracts of various flowers were also analysed; the small quantity of sugar present in them may be seen from the author's calculation, that in order to obtain 1 gram of sugar (corresponding

* Bot. Ztg. xliv. (1886) pp. 151–2. † Cf. *supra*, p. 642.
‡ SB. K. Preuss. Akad. Wiss. Berlin, xlix. (1885) pp. 1115–26 (1 pl.).
§ Zeitschr. f. Physiol. Chem., x. (1886) pp. 227–47.

with 1·3 gram of honey), the bees must suck 2129 flowers of the alpine rose, 2000 of the acacia (*Robinia viscosa*), and 5000 of the sainfoin (*Onobrychis sativa*).

Proteid Substance in Latex.*—The examination of seeds of various plants has shown that certain globulins, albumose, albuminates, and coagulated proteids, can be isolated; and Martin has investigated the nature of certain proteids in the dried milk of the fruit of the papaw plant (*Carica papaya*). Mr. J. R. Green now gives the results of his researches on several caoutchouc-yielding plants, and describes the numerous tests which he applied to the latex, preserved in alcohol. These researches were made on *Mimusops globosa*, *Manihot Glaziovii*, *Brosimum galactodendron*, and others; as well as on lettuce and cabbage plants. He agrees with Martin that no true peptone is present in plants.

The following are the proteids found to be present:—(1) A dialysable proteid, resembling peptone, but which is not converted into true peptone by the action of pepsin. Martin's proteid obtained from the papaw plant gives the biuret reaction, whereas this proteid does not do so. (2) Hemialbumose, found in the lettuce; this resembles Vines's hemialbumose and Martin's *a*-phytalbumose. (3) Albumose, in *Mimusops*. (4) Albumin, in *Brosimum*. (5) Globulin, in *Manihot*. Both the two last seem to be the same bodies as described by Martin as occurring in papaw juice. The albumin is probably the same substance as Boussingault's "vegetable fibrin"; till lately no true albumin has been found in plants.

New Nitrogenous Constituent of Plants.†—Herren E. Schulze and E. Bosshard have found a new chemical substance in young clover-plants, the cotyledons of cucumber-seedlings, young lupins, probably in the pollen of *Pinus sylvestris*, and ergot, usually in very minute quantities, in the last case alone amounting to 0·1 per cent. It crystallizes with the composition $C_{10}H_{20}N_8O_8$, and its discoverers have given it the name *vernin*. By heating with hydrochloric acid it yields guanin.

Pith of Dicotyledons.‡—Herr F. v. Mentovich describes the pith in a large number of dicotyledonous orders, which he classifies under two groups, climbing and non-climbing plants. The following are some of the more important observations:—

The pith-cells of woody plants may be classed under two physiological groups, according as their cell-walls are lignified or remain unchanged. In those cases where all the cells are lignified the change usually commences in the first, less often in the second or in later years. Passive pith results from the cells losing their vitality after becoming lignified; their walls are then all of the same thickness.

* Proc. Roy. Soc., xl. (1886) pp. 28–39.

† Zeitschr. f. Physiol. Chemie, x. (1886) pp. 80–9. See Bot. Centralbl., xxvi. (1886) p. 100.

‡ Mentovich, F. von, 'Histology of Pith, with especial reference to Dicotyledons' (Magyar), 37 pp. (1 pl.), Kolozsvar, 1885. See Bot. Centralbl., xxvi. (1886) p. 67.

Heterogeneous pith is the result when some of the cells still remain active at a later period, performing the function of a reservoir of food-material. The walls of these cells are usually thicker and more pitted: they are mostly the peripheral cells.

It is not unfrequently the case that while some of the pith-cells lignify, others still show the cellulose-reaction. It is then always the central part of the pith which remains unchanged, while the peripheral cells lignify early and often become very thick-walled. In other cases finally the pith-cells do not lignify at all, and then later changes sometimes occur, such as the disappearance of older cells and the appearance of new ones in their place. When special elements are found in the pith, such as laticiferous vessels, resin-passages, tannin-receptacles, calcium oxalate, &c., these almost invariably occur also in the cortex.

It is very rare for the pith to remain entirely unchanged. The pith of climbing shows no important differences from that of non-climbing plants.

Mechanical Sheaths of Secreting Vessels.*—Dr. M. Mœbius has investigated the anatomical details where intercellular secreting vessels are surrounded by thickened cells, in a number of examples, especially a large number of species of *Pinus*, the roots of *Philodendron*, the stem of the ivy, the ovary of different species of Bromeliaceæ, the leaf-stalk of *Angiopteris*, &c.

The species of *Pinus* examined may be divided into three classes: —(1) Those in which the resin-passages are surrounded by sclerenchymatous bast-like cells; (2) surrounded by thin-walled cells with some bast-like cells intermixed; (3) surrounded by thin-walled cells only. In all the species of *Philodendron* examined, with one exception, the epithelium of the secreting vessels in the adventitious roots is surrounded by sclerenchymatous cells, forming a partially open or an entirely closed sheath. Three different modifications of this sheath are described. The author believes the function of the sheath to be in all cases a purely mechanical one.

Medullary Rays of Dicotyledons.†—Herr E. Zache has made a comparative examination of the medullary rays in thirteen different species of dicotyledonous trees and shrubs. He finds the number in a square mm. to vary, as a general rule, between thirty and sixty, a strong deviation occurring in one direction in *Platanus orientalis* with eight, and in the other direction in *Prunus Padus* and *Castanea vesca* with ninety.

Normal Root-buds.‡—By normal root-buds Dr. M. W. Beyerinck means such as are formed in some plants during normal growth, not as the result of wounds such as those formed in callus. In *Populus alba* and *Geranium sanguineum* the author observed root-buds inter-

* Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) pp. 262–301 (1 pl.).

† Zeitschr. f. Naturwiss., v. (1886) pp. 1–29. Cf. this Journal, v. (1885) p. 826.

‡ Nederl. Kruidk. Arch., 1885, p. 162. See Bot. Centralbl., xxv. (1886) p. 296.

mediate between the normal and callus-buds, formed on normal roots from callus, but without any previous injury. In the former case they spring from the parenchyma of the secondary cortex around the origin of the lateral roots; in the latter case by the metamorphosis of dormant lateral roots which have remained within the secondary cortex. The same has been observed also in *Solanum Dulcamara* and *Brassica oleracea* when pulled up and replanted upside down. Apices of roots form leaf or flower-buds in *Ophioglossum*, *Selaginella*, *Platycerium*, *Neottia nidus-avis*, *Catasetum*, *Anthurium*, *Dioscorea*, *Viola sylvestris*, and *Balsamina*.

In almost all plants which produce root-buds the mode of origin is accompanied by some morphological peculiarity; only in the most nearly related species is it altogether or even nearly identical.

Dr. Beyerinck classifies root-buds according to the tissue in which they are formed, viz. either immediately below the growing apex of the root, in the pericambium, or from the older parts; and in this case either by direct metamorphosis of a dormant rudiment of a root, or from that part of the primary cortex of a lateral root which still remains imprisoned in the cortex of the mother-root, or thirdly from the merismatic layers which lie beneath the secondary periderm after the primary cortex has been thrown off, or beneath the suberous layer which clothes the primary cortex. The author gives a number of illustrations of the varieties of these different primary groups. In most Podostemaceæ the branching appears to depend mainly on the formation of root-buds, corresponding in their position to the two xylem-bundles of the biradiate root; they are formed in the central part of the primary cortex quite independently of the central cylinder.

Serial Buds.*—According to M. J. Velenovsky, serial buds occur normally in dicotyledons, while in monocotyledons he has observed only a single case. They occur as buds on all the permanent axes, frequently as branches in the inflorescence. In some plants (*Lonicera*, *Sambucus*) they are found in every leaf-axil; in others (*Fagus*, *Carpinus*) only on luxuriant shoots. In *Raphanus Raphanistrum* there are not unfrequently as many as five serial branches in the axil of the leaf, carrying the subtending leaf with the last shoot far from the main stem. The development of these buds can be followed out well in *Robinia Pseudacacia*; the serial buds are subordinate to the first bud, but are formed in the same way, and originate from the same cell-tissue. The first axillary branch always dies in the following year, and then the first serial bud developes into a branch.

The function of these serial buds is to form a reserve in case of the loss of the first bud; sometimes they developе into vegetative axes, sometimes into flowers.

Anatomical Structure of Senega-root.†—Herr O. Linde describes in detail the structure of the root of *Polygala Senega*, which presents several peculiarities. The medullary rays are all in connection with

* See Bot. Centralbl., xxvi. (1886) p. 10 (original in Bohemian).
† Flora, lxix. (1886) pp. 1–32 (1 pl.).

one another in the centre. The secondary increase in thickness of the root is anomalous in several respects. The thin-walled parenchyma, whether it increases radially or tangentially, i. e. whether it forms medullary rays or wood-parenchyma, remains capable of growth in all directions, and therefore of forming new cambium. Details are also given of the structure of the root in other species of *Polygala*.

Partition of the Axis.*—M. D. Clos applies this term to any mode of division of the stem or root, restricting the term "dichotomy" to its older signification, the elongation of two buds produced in the axil of two upper leaves.

Partition of the root, or *polyrhizy*, may be of four different kinds:—(1) The fasciculate roots of monocotyledons and of some dicotyledons, where the main axis is more or less destroyed, or very feebly developed (*Inula Conyza*). (2) Partition of the main axis into two, three, or four equal or unequal branches (*Scorzonera*, *Daucus*, *Rumex*, *Cucurbita Pepo* and *maxima*). (3) Bipartition of adventitious and especially of fleshy roots (*Dioscorea Batatas*). (4) Arrangement of the secondary roots in small bundles along the main axis (*Reseda*, *Fumaria*.) This may occur also on cladodes of *Opuntia* kept some time in water.

Partition of the axis generally may be classed under the three heads of Bipartition, Tripartition, and Multipartition or Polyclady. Bipartition may be equal or unequal, and either of these may be normal or abnormal.

A large number of special cases are described, taken from a great variety of natural orders.

Relation between the Bloom on Leaves and the Distribution of the Stomata.†—Mr. F. Darwin finds a connection between the relative number of stomata on the upper and under surface of leaves and the presence of "bloom" or the coating of wax which protects the stomata from the rain which would otherwise close them and render them useless. In those leaves which have no bloom on either surface there is a strong tendency towards the accumulation of stomata on the lower surface; in all those in which the bloom occurs on the upper surface only, there are also stomata on that surface; while of those which have bloom on the under surface only, 83 per cent. are entirely destitute of stomata on the upper surface.

Double Flowers.‡—Rev. W. Woolls remarks that few double flowers have as yet been found amongst the Australian plants in the wild state. He mentions the Epacrids as having an especial tendency to produce double flowers, e. g. *Epacris purpurascens*, *E. microphylla*, *E. impressa*, *Sprengelia incarnata*, *Astroloma humifusum*. Amongst other orders he has found the following plants: *Ranunculus lappaceus*, *Eriostemon obovalis*, *Boronia pinnata*, *Wahlenbergia gracilis*; the last is remarkable as it so soon loses its stamens after flowering. Although

* Mém. Acad. Sci. Toulouse, vii. (1885) pp. 222–56 (2 pls.).
† Journ. Linn. Soc. Lond. (Bot.), xxii. (1886) pp. 99–116.
‡ Proc. Linn. Soc. N. S. Wales, x. (1885) pp. 455–8.

it is usually considered that "hybridization aided by cultivation" is the chief cause of double flowers, yet it is evident that some other factor must be present, since all the above occur double in the wild state. The author deems it probable that insects play a very important part in this matter.

Superposed Stamens.*—Mr. T. Meehan brings forward arguments in favour of the view that when stamens occur opposite to the petals and attached to their base, the ordinary theory of the suppression of an intermediate whorl of stamens does not account for the phenomenon so well as the hypothesis that the stamen is not in this case a metamorphosed leaf, but is a modified axial bud at the base of the petal. This view is supported by a description of the structure of the organs in question in *Mahernia verticillata*, a plant belonging to the Büttneriaceæ.

Composition of the Pollen of the Pine.†—Dr. A. v. Planta gives the following as the composition of the pollen of the pine:—Water, 7·66 per cent.; N, 2·65; (N × 6·25, 16·56); non-nitrogenous matter, 72·48; ash, 3·30; hypoxanthin and guanin, 0·04; saccharose, 11·24; starch, 7·06; cuticule, 21·97. By cuticule is meant the chemically changed substance of the cell-wall which overlays various structures and is in direct contact with the air. It is estimated by digesting the pollen for three days in a 5 per cent. solution of potash in alcohol, which removes the oil, &c. The residue is then boiled with semi-normal hydrochloric acid for two hours, which removes the last traces of starch; other soluble matters are removed by ether, and nothing but cuticle remains.

Composition of the Ash of the Pollen of Pinus sylvestris.‡—MM. A. Famintzin and D. S. Przybytek find, in the pollen of *Pinus sylvestris*, 6·79 per cent. water and 3·30 per cent. ash. The composition of the ash is as follows:—K_2O, 34·95 per cent.; N_2O, 3·62; MgO, 6·99; CaO, 0·88; P_2O_5, 28·56; SO_3, 14·83; Cl, 0·99; Fe_2O_3 and Al_2O_3, 5·30; Mn_2O_3, a trace. The proportion of nitrogen was 2·4 per cent. By treating the pollen with a 1 per cent. solution of soda, and acidulating with hydrochloric acid, a small quantity of a precipitate was obtained corresponding in its reaction to nuclein.

Heterocarpous Fruits.§—Dr. A. N. Lundström illustrates the phenomenon of heterocarpy in fruits, especially in different species of *Calendula* and *Dimorphotheca* belonging to the Compositæ. Three different forms may often be found in the same species, viz.:—(1) anemophilous fruits, slightly curved, and with the outer pericarp extended into a floating apparatus for carriage through the air; (2) bristle-fruits, without any wing, and with a number of stiff hairs

* Proc. Acad. Nat. Sci. Philad., 1886, pp. 9–11 (1 fig.).

† Landw. Versuchs-Stat., 1885, pp. 215–30. See Journ. Chem. Soc. Lond.—Abstr., 1. (1886) p. 91. Cf. this Journal, *ante*, p. 97.

‡ Bull. Acad. Imp. Sci. St. Pétersbourg, xxx. (1886) pp. 357–62. Cf. this Journal, *ante*, p. 97.

§ Naturv. Studentsälls. Upsala (Bot. Sekt.) Nov. 3, 1885. See Bot. Centralbl., xxv. (1886) p. 319.

on the dorsal side pointing downwards, adapted for carriage by adherence to the hair or wool of animals; (3) larva-like forms, without wings or bristles, but with the outer pericarp folded in a wavy manner, so as to resemble the larvæ of microlepidoptera. The 1st and 2nd pass into one another by intermediate forms; the 3rd is an illustration of true mimicry, for the promotion of dissemination by deceiving insectivorous birds; these fruits are usually found in the central part of the inflorescence.

Testa of Leguminous Seeds.*—Mr. L. H. Pammel describes the structure of the testa of a number of leguminous seeds, including that of the Calabar-bean, *Physostigma venenosum*, and the remarkably hard testa of the Kentucky coffee-bean, *Gymnocladus canadensis*, in which, in addition to the five distinct layers found elsewhere, there is a sixth very strongly developed layer of sclerenchyma.

Vegetable Metagenesis.†—A new and consistent system of nomenclature is proposed by Prof. W. R. M'Nab for variously named organs and processes in plants.

Instead of using "oophore" to express the sexual form of a plant, he suggests *gametophore*; and as this may be either male or female, *androgametophore* and *gynogametophore* serve to distinguish them. The sexual cells themselves are *androgametes* or *gynogametes*, instead of "zoosperms" and "egg-cells." The union of these two by a process of "zygosis" will give rise to a *zygote* or "ovum." The organ in which these sexual cells are formed are *androgametangia* and *gynogametangia*, instead of the typical "antheridium" and "archegonium." In this way a more uniform set of words is used for similar stages in the asexual stages (spore, sporangium and sporophore): and in the sexual stages (gamete, gametangium and gametophore).

Moreover, asexual stages are either spores developed in sporangia, or buds which are not so contained, e.g. conidia, gemmæ, and fragments of a plant; and for these latter the author proposes *blastidules*: whilst *blastogenesis* would be the process corresponding to sporogenesis. When metagenesis occurs, it is an alternation between gamogenesis and sporogenesis; whilst blastogenesis may occur either in the sporophore or in the gametophore stage.

B. Physiology. ‡

Fertilization by Pollen-tubes.§—Mr. J. Kruttschnitt adduces fresh observations in support of his theory that the fertilization of ovules is effected without the agency of so-called pollen-tubes, the conducting tissue of the style serving to convey the fovilla from the pollen-grains to the entire inner surface of the ovary.

* Bull. Torrey Bot. Club, xiii. (1886) pp. 17–24 (2 pls.).

† Scientif. Proc. R. Dublin Soc., iv. (1885) pp. 451–4.

‡ This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

§ Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 62–5 (1 pl.).

Endosperm of Dicotyledons.*—Prof. C. F. Hegelmaier confirms the accepted view that the nuclei of the endosperm result in almost all cases from division of the secondary nucleus of the embryo-sac which has been formed by the coalescence of the two polar nuclei. Exceptions appear to occur uniformly in *Hibiscus Trionum*, and probably in many cases in *Adonis autumnalis*, where this coalescence does not take place, but the endosperm is formed by repeated bipartition of the two free nuclei of the embryo-sac which remain distinct. The further development of the endosperm may vary according to four types, viz.:—

1. The omnilateral peripheral type. The nuclei formed by division from the secondary nucleus of the embryo-sac occupy the whole periphery of the embryo-sac; the first cells arise as a simple connected layer clothing the entire embryo-sac, and ultimately filling it up by centripetal divisions. This is the most common mode; examples are furnished by *Adonis*, *Caltha*, *Cotoneaster*, *Malva*, *Hibiscus*, &c.

2. The peripheral simultaneous type. The cells are formed simultaneously in the entire periphery of the embryo-sac; there is no later centripetal division of them; the comparatively narrow embryo-sac being filled up by the first formation:—*Bocconia*, *Scabiosa*, *Euphorbia*.

3. The unilateral peripheral type. Cell-formation takes place chiefly in the end of the embryo-sac nearest the micropyle; the tissue formed here afterwards extending towards the chalaza:—*Trigonella*, *Phaseolus*, *Fagopyrum*.

4. The endogenous type. The first cells of the endosperm are not formed in the periphery of the embryo-sac, but simultaneously throughout the whole protoplasm. In this type alone is the entire mass of the embryo-sac filled uniformly with nuclei before the formation of the endosperm-cells:—Observed only in *Eranthis hiemalis*.

The author observed in many cases both direct and indirect cell-division even in cases of normal development.

Action of Saline Solutions on Germination.†—According to experiments carried out by Herr Jarius, which are described in detail, no injurious effects on the germination of seeds can possibly result from the use of manures, as their solution in the soil can never exceed 0·4 per cent. Still the seed should not be sown immediately on the manure, as in such a case it is possible that a stronger solution may be formed. In a table is given the ratio between the growth of the radicle and plumule of several seeds when subject during growth to different strengths of the same solution.

Action of Hydrocyanic Acid on Seeds.‡—Herr E. Schär corroborates Schönbein's experiments on the action of hydrocyanic acid

* Nova Acta K. Leop.-Carol. Deutsch. Akad. Naturforscher, xlix., 104 pp. See Bot. Centralbl., xxv. (1886) p. 302.

† Landw. Versuchs-Stat., 1885, pp. 149-78. See Journ. Chem. Soc. Lond., Abstr., l. (1886) p. 90.

‡ Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 575, from Chem. Centr., cxxxi. (1885) p. 826.

on the germination of seeds. He also finds that this acid arrests the germination, but on its removal germination takes place to an extent almost equal to what it would be if they had only been treated with pure water. He also adds that hydrogen sulphide and mercuric chloride arrest germination, but when the solution is very dilute (0·5 per 1000) 60 to 80 per cent. of the seeds still germinate.

Formation of Amides during the germination of seeds in the dark.*—Herren B. Schulze and E. Flechsig find that when the seeds of leguminous plants or cereals germinate in the dark, the conversion of albuminoids into asparagin and its congeners is very gradual; and that it also varies considerably, leguminous plants, and especially lupines, producing, not only absolutely but also relatively, larger quantities of amides than cereals do. Seeds, when germinating, do not of necessity produce an amount of amides at all proportional to their nitrogenous reserve-matter.

Absorption of Light by the Assimilating Organs.†—Herr J. Reinke has made a series of photometric observations on the absorption of light by the assimilating organs in a variety of plants, including a number of flowering plants, green, brown, and red seaweeds. For the colouring matter of the two latter classes, contained in the living active chromatophore, he proposes the terms *phæophyll* and *rhodophyll* respectively.

The author suggests that the colourless albuminous constituent of the chromatophores acts like a ferment in enabling the chlorophyll to decompose the compound CO_3H_2 with evolution of oxygen whenever the atoms of the albuminoid are set in motion by light with sufficiently large vibrations. When the body of the cell and the chromatophore die, the molecule of chlorophyll breaks up into its colourless and coloured group of atoms. The coloured constituent is soluble in alcohol, and either breaks up by dissolution into a green and a yellow constituent, or this separation exists previously. Phæophyll and rhodophyll consist each in the same way of an albuminoid and a coloured constituent. In the former case the coloured constituent is very nearly related to the coloured group of atoms in the molecule of chlorophyll.

In the coloured constituent of rhodophyll two groups of atoms can easily be distinguished, one of them agreeing, in its light-absorption and solubility in alcohol, with the green constituent of chlorophyll, while the other absorbs most strongly the green rays which the chlorophyll allows to pass through most completely, and is insoluble in alcohol, but soluble in water. This group of atoms is characterized by an orange-red fluorescence on the death of the chromatophore.

Development and Absorption of Heat by Plants.‡—M. G. Bonnier finds that the quantities of heat developed in a unit of time by

* Landw. Versuchs.-Stat., 1885, pp. 137-49. See Journ. Chem. Soc. Lond. —Abstr., l. (1886) p. 90.

† Bot. Ztg., xliv. (1886) pp. 161-71, 177-88, 193-200, 209-18, 225-32, 241-8 (1 pl.).

‡ Comptes Rendus, cii. (1886) pp. 448-50.

the same weight of living tissues differ very considerably with the stage of development, and usually pass through successive maxima and minima. The most important maxima correspond with the commencement of germination and flowering respectively. These are also the stages at which respiration is most intense, but if the quantities of heat corresponding with the amount of carbonic anhydride evolved in a given time are compared with the heat actually developed during the same time, there is never any sensible agreement between the two quantities. The quantity of heat developed is not equal to that which would be produced by the combustion of the carbon lost by the organism.

At the commencement of germination, the heat actually developed is much greater than that calculated from the amount of carbonic anhydride evolved, and even greater than that which would be developed by the combination of carbon with the whole of the oxygen absorbed during germination; but after germination, and during the formation and maturing of the fruit, the reverse is the case.

These facts agree with the hypothesis that the reserve substances, which are not directly assimilable, are usually formed in the organism with absorption of heat; whilst the transformation of these substances into assimilable materials is accompanied, as a rule, by a development of heat. During the consumption of the reserve substances, as at the commencement of germination, the heat developed by the transformation of these substances is added to that developed by the formation of carbonic anhydride; but whilst reserve substances are being formed, as during the maturing of the fruit, the heat actually developed is the difference between that absorbed in the formation of the reserve material and that developed by the formation of carbonic anhydride.

Movements of the Tendrils of Cucurbita.*—From observations of the movements of the tendrils of *Cucurbita maxima* and *Pepo*, Prof. D. P. Penhallow has come to the following general conclusions:—Growth is promoted by an increase of temperature and humidity, but may be retarded by an increase of temperature when other conditions are not favourable. The conditions favourable to growth, arising from temperature and humidity, may cause greater growth during the day, in opposition to the retarding influence of light. Growth is retarded by excessive transpiration. The conditions to which the plant is subject being variable, there is a corresponding periodicity in the vital phenomena. Movements of tendrils and terminal buds, being phenomena of growth, are modified by whatever variations of condition affect growth.

The term *vibrogen* is given by Prof. Penhallow to certain areas of tissue in the tendrils immediately beneath the epidermis, composed of rather large and rounded parenchymatous cells with somewhat thin walls, and containing protoplasm and a large amount of chlorophyll, which appear to play an important part in the movements.

With reference to circumnutation of the tendrils, movements of

* Amer. Journ. Sci., xxxi. (1886) pp. 46–57, 100–14, 178–89 (1 pl.).

the tendril or petiole are due to unequal growth by producing unequal tension of tissues. The unequal growth is chiefly defined in the vibrogen tissue, which may therefore be regarded as the seat of movement. The band of unequal growth does not arise at successive points of the circumference. The vibrogen tissue consists of three longitudinal bands, each of which becomes more active in turn, without regular order. Bending under the influence of irritation results from cessation of growth and condensation of structure. The collenchymatous tissue is that which is chiefly concerned in variations of tension under mechanical stimuli. Coiling results (by contact) from cessation of growth and condensation of structure or (free coiling) from increased inequality of tension due to continued growth. Transmission of impulses is effected through continuity of protoplasm in the active tissues.

Ascent of Sap.*—M. L. Errera describes a series of experiments on this subject, made on the large vessels of *Vitis vulpina*. By injecting into the stem a solution of gelatin melting at 33° C., and coloured with Indian ink, he found that in all cases, when the experiment was carried out with all possible precautions, the injected branch took up no water and faded in a few hours. This was considered conclusive evidence against the imbibition theory of Sachs, and in favour of the view that the ascending current of sap takes place through the cavities of the vessels and tracheides.

Variation of Water in Trees and Shrubs.†—According to Prof. D. P. Penhallow, the hydration of woody plants is not constant for all seasons, but depends on conditions of growth. It reaches its maximum during the latter part of May or early in June, and its minimum during January. It is greatest in the sap-wood; least in the heart-wood. The greatest hydration is directly correlated with most active growth of the plant, while lignification and the storage of starch and other products are correlated with diminishing hydration. The amount of water in dead wood varied, in 15 species of tree, between 12·9 and 19·0 per cent. In living wood, the maximum percentage observed was 61; it is usually somewhat less in the second year than in the first.

Migration of Nitrates in Plant Tissues.‡—M. G. Capus's method of study was the microchemical one. Sections of various plant tissues were immersed in a weak solution of Arnaud's reagent, cinchonamine hydrochloride acidified with hydrochloric acid. After a longer or shorter period, according to the quantity of nitrates present, crystals of cinchonamine nitrate separate out; the size, shape, and position of the crystals, whether within or without the cell, also afford indications of the relative abundance of nitrates in the different tissues.

The author's observations demonstrate that many plants have the

* CR. Soc. R. Bot. Belg., xxv. (1886) pp. 24–32.

† Canadian Record of Science, ii. (1886) pp. 105–16.

‡ Ann. Agronom., xii. (1886) pp. 24–42. Cf. Journ. Chem. Soc. Lond.—Abstr., l. (1886) pp. 484–5.

peculiar property of storing up an excess or reserve of nitrates especially in the medullary parenchyma of the stem and in the cortical parenchyma. This reserve is greatest at the period immediately preceding the flowering; the nitrates are then stored chiefly in the lower third of the stem, and are designed for the nutriment of the physiological summit of the plant, namely the flowering axis. If a branch containing nitrates in the stem, and showing a flowering axis, be cut off and plunged in distilled water, the nitrates soon disappear, and as they are not found in the water, must be considered to have been used by the plant. Also, if a branch of this sort be cut off above the reserve of nitrates and plunged in a 0·004 solution of potassium nitrate, sections just below the flowers soon show the presence of nitrates. The power of accumulating nitrates is a specific property of certain plants. Among those particularly rich in this reserve of nitrates are *Solanum tuberosum*, *Urtica dioica*, *Mercurialis annua*, *Sinapis alba*, *Brassica oleracea*, *Spinacia oleracea*. Amongst those not containing nitrates in excess are *Senecio vulgaris*, *Syringa vulgaris*, *Viola tricolor*, *Malva*, *Rumex*, *Phaseolus*, and *Chrysanthemum*. Berthelot and André consider that the cells of the stem have the power of elaborating nitrates. Boussingault's opinion, which is corroborated by the author's experiments, was that the nitrates enter the plant as such from without, and are assimilated in the plant. Branches of dahlia, selected when free from nitrates, and plunged into a solution of ammonium sulphate, have never shown the formation of nitrates in their tissues. The author suggests that exhausting crops are those which possess the special property of storing up nitrates.

Action of Salicylic Acid on Ferments.*—Mr. A. B. Griffiths finds that a solution containing 0·2 gr. of salicylic acid per 1000 c.cm. of water destroys very quickly *Mycoderma aceti*, *Bacterium lactis*, and the butyric bacillus. It appears to act on and dissolve the cell-walls of these organisms, as also of dead *Torulæ;* although living *Torulæ* are not acted on, nevertheless their activity is impeded by the salicylic acid. Thus neither yeast nor saliva exert their fermentative faculties in the presence of this solution of salicylic acid. The yeast can, however, be revivified by treatment with sodium phosphate and potassium nitrate. Hence "diseased yeast" may be advantageously treated with such a solution of salicylic acid which is far below the poisonous strength.

Behaviour of Guanin, Xanthin, and Hypoxanthin in the Fermentation of Yeast.†—Meaning by hypoxanthin, hypoxanthin + adenin, Herr V. Lehmann finds that when yeast is allowed to stand in water at the ordinary temperature of a room, only small traces of these bases are set free from the nuclein; while if the temperature is that of the body, the entire quantity of hypoxanthin is smaller, that of guanin + xanthin larger.

* Chem. News, liii. (1886) pp. 28–9.

† Zeitschr. f. Physiol. Chemie, ix. (1885) pp. 563–5. See Bot. Centralbl., xxvi. (1886) p. 101.

B. CRYPTOGAMIA.

Apospory in the Thallophyta.*—Prof. W. R. M'Nab calls attention to certain phenomena in the Peronosporeæ and in *Vaucheria* which are to be regarded as cases of apospory, which occurs only under certain conditions. In *Cystopus candidus* the moniliform series of cells found below the epithelium of the host and usually called conidia, are to be considered rather as detachable sporangia, from comparison with other members of the group. In *C. Portulaceæ* the first and oldest sporangium of the series behaves differently from the remaining ones; it does not liberate its contents, but develops directly into a new thallus; it is aposporous.

Phytophthora infestans exhibits apospory when the sporangia are grown in moist air, hyphæ being produced; whereas if placed in water zoospores are developed.

Peronospora gangliiformis and *P. parasitica* also exhibit the phenomena.

In *Vaucheria tuberosa* there is a complete series of gradations from the production of ciliated zoospores to spores which do not leave the sporangium, and to complete apospory.

The author does not agree with Bower in regarding as apospory the artificial production of protonema from cut pieces of sporangium in certain mosses; it rather approaches "blastogenesis."

In *Batrachospermum* an apospory is apparently present, where the spores are suppressed, the ovum giving rise to a protonema.

In the Saprolegnieæ apogamy has been observed, and Prof. M'Nab suggests that this is a case of "apandry," where the antheridium fuses with the oogonium. The same term would be applied to the pollen-tube.

Cryptogamia Vascularia.

Development of the Antheridium of Ferns.†—Mr. D. H. Campbell describes the development of the antheridium in *Onoclea Struthiopteris* and *sensibilis*.

When the mother-cell of the antheridium is first cut off from the male prothallium, it contains a distinct central nucleus. The first wall formed within the antheridium is funnel-shaped, with the broad portion directed upward. The second wall is approximately hemispherical and parallel to the outer wall of the antheridium. Finally, a third wall is formed, resembling the first in form, and cutting off the covering-cell of the antheridium. The antheridium now consists of four cells, three parietal and one central; the two lower parietal cells are annular, the upper one flat; each contains a nucleus. The division of the central cell begins either before or immediately after the formation of the covering-cell. The first wall is nearly vertical, and is soon followed by a second vertical one at right angles. The

* Scientif. Proc. R. Dublin. Soc., iv. (1885) pp. 466–9.

† Bull. Torrey Bot. Club, xiii. (1886) pp. 49–52 (1 pl.). Cf. this Journal, v. (1886) p. 493; *ante*, p. 106.

ultimate number of cells in the antheridium varies a good deal even in the same species. Each of the cells formed from the central cells contains a nucleus, and the antherozoids are formed directly from the nuclei. The nucleus becomes indistinct, but does not actually disappear; as soon as it is again distinctly visible, it has increased in size and has become curved; not only these curved nuclei, but the sperm-cells themselves, increase so greatly in size that the parietal cells are almost obliterated. The antherozoids escape by the dissolution of the division-walls. They remain for a few moments after their escape enclosed in the remains of the wall of the mother-cell, but this is soon ruptured, and the antherozoid swims rapidly away, dragging after it the remains of the contents of the mother-cell as a very delicate vesicle.

Muscineæ.

Assimilating System of the Sporogonium of Mosses.*—Dr. G. Haberlandt points out that in most Bryineæ the sporogonium has a more or less perfect assimilating system, situated generally in the innermost layer of the wall of the capsule, and the peripheral parenchymatous layers of its neck, especially in the latter when well developed. Examples are furnished by *Phascomitrium pyriforme*, *Funaria hygrometrica*, *Bryum argenteum*, *Webera elongata*, *Meesia longiseta*, and *Tayloria serrata*. The same function is performed by the apophysis of most species of *Splachnum* as long as it is still green. The assimilating tissue is a palisade- or spongy parenchyma. It is marked by the presence of stomata, which are absent where this tissue is wanting, as in the Sphagnaceæ and Andreæaceæ. The amount of chlorophyll contained in this tissue is very considerable.

Formation of Pits in Mosses.†—Herr K. G. Limpricht states, that in all the European Sphagnaceæ there are simple pits in the wood-cells and medullary cells of the stem and branches, and that they are especially abundant at the spot from which springs a tuft of branches; they are found also in the septa of the swollen cells at the base of the leaves. Septa with sieve-like thin spots, rudimentary sieve-plates, occur in the stem and branches of *Sphagnum*, in the transverse section of many species, as *S. contortum* and *squarrosum*, both in the spongy outer cortex and in the woody and medullary layers. These thin spots are often ranged irregularly, in other cases in radial rows.

In the true mosses, simple pits are a widely spread phenomenon, not only in the axis, but also in the leaves; in the thin-walled cells of the conducting bundles they appear to be wanting. The author finds them in great abundance in the stem of *Andreæa*, *Dicranum*, *Grimmia*, *Racomitrium*, *Bryum*, *Philonotis*, *Breutelia*, *Webera*, *Mnium*, *Bartramia*, *Hypnum*, &c. In the mid-rib of the leaves they are

* Flora, lxix. (1886) pp. 45–7.
† JB. Schles. Gesell. Vaterl. Cultur, lxii. (1885) pp. 289–90.

found especially in the longitudinal walls of the cells; in many species of *Dicranum* and *Hypnum* they occur also in the lamina.

Paraphyses of Mosses.*—Herr F. Kienitz-Gerloff confirms the hypothesis of Leitgeb † that the structure of the female receptacle in *Corsinia* is specially adapted for keeping the archegonia moist until impregnation by the antherozoids has taken place; and points out that in a large number of mosses the same function is performed by the paraphyses, especially in those dicœcious species growing in very dry situations, in which the male and female tufts are often widely separated, such as *Polystichum piliferum*. This view is confirmed by the fact that paraphyses are often nearly or entirely wanting in those species which grow in water or in very moist situations, like *Fontinalis* and *Sphagnum*.

Hair-like Filaments on Moss-stems.‡—Mr. W. Archer draws attention to some reddish, arborescent filaments on the stem of *Aulacomnion palustre*, resembling an algal parasite, but which he finds to be outgrowths from the stem. They give off numerous branches, which become interlaced and involve the leaves of the moss. He suggests that this may be a "kind of secondary Protonema," which, if detached, might give rise to a new moss plant.

New Genus of Mosses.§—Herr K. G. Limpricht classifies the cleistocarpous mosses of Germany under seven genera, viz.:—1. Nanomitrium (*Ephemerum tenerum* Bruch). 2. Ephemerum. 3. Ephemerella. 4. Physcomitrella. 5. Acaulon. 6. Phascum. 7. Mildeella n. gen., with the following characters:—

Vegetative characters agreeing with those of Euphascum, monœcious; the true male shoots often two or three placed behind one another on the same pseudaxis. Seta reddish yellow with central cord, usually shorter than the perigone; foot somewhat swollen; vagina ovate. Capsule thick-walled, with distinct neck and persistent straight or oblique conical operculum; wall of two layers; cells of the exothecium thick-walled, with a few rows of smaller roundish hexagonal cells in the annular zone, but without the characters of annular cells; cells of operculum elongated, ascending slightly to the left; stomata few, only in the neck-portion; tissue of neck loose, with clearly defined axis; air-cavity without threads. Peristome distinctly developed, composed of sixteen filiform papillose yellow teeth, each of two layers; often only fragmentary in the upper part, laterally coalescent at the base. Calyptra cap-shaped. Its nearest affinity is with *Barbula*.

Hepaticæ of the Amazon and Andes.‖—In this magnificent work Dr. R. Spruce describes 577 species of Equatorial American Hepaticæ,

* Bot. Ztg., xliv. (1886) pp. 248–51.

† See this Journal, v. (1885) p. 1035.

‡ Ann. and Mag. Nat. Hist., xvii. (1886) p. 163.

§ Rabenhorst's 'Krypt.-Flora v. Deutschland,' Bd. iv., Die Laubmoose v. K. G. Limpricht, Lief. 3, Leipzig, 1886 (2 figs). Cf. this Journal, *ante*, p. 108.

‖ Spruce, R., 'Hepaticæ Amazonicæ et Andinæ,' 588 pp. and 22 pls. London, 1884–5. See Journ. of Bot., xxiv. (1886) p. 122.

the majority new to science, and very nearly all collected by himself between 1849 and 1862. Of these species, 283 are Jubuleæ, 274 Jungermannieæ, and 22 Marchantieæ. They are arranged under 51 genera, of which 8 are new, viz. *Myriocolea*, *Chætocolea*, *Arachniopsis*, *Mytilopsis*, *Anomoclada*, *Clasmatocolea*, *Syzygiella*, and *Symphyomitra*. Of *Lejeunia* he describes 234 species, which he distributes among 35 sections.

Algæ.

Development of Tissue-systems in Algæ.*—Herr N. Wille has examined the structure and development of eleven genera of Florideæ, which he divides into two groups:—those with a single apical cell, and those with an apical mass of cells with peripheral growth. The first of these groups are again divided into four, and the second into two types.

1. Delesseria-type. (*Hydrolapathum sanguineum*, *Delesseria alata*, *D. sinuosa*, *Odonthalia dentata*). Growth always takes place by a single apical cell. The transverse walls which separate the primary segments are at first straight, but afterwards become curved convexly below. The primary segments are divided by two vertical walls into a smaller middle, and two larger marginal cells.

2. Rhodophyllis-type. (*Rhodophyllis bifidus.*) Here there is a three-edged apical cell, from which segments capable of division are separated alternately on the two sides. The thallus is afterwards divided by walls parallel to the surface, and consists therefore of two outer layers which have endochrome only on their outer walls and form the assimilating system, and of one or more inner layers which constitute the conducting system.

3. Ceramium-type. (*Ptilota elegans*, *Bonnemaisonia asparagoides.*) The apical growth in this group has already been fully described by others.

4. Lomentaria-type. (*Lomentaria kaliformis.*) The apical cell is conical, and divides in several directions, some parallel to the base, others nearly vertical to the surface, by which segments are separated laterally. These last cells again divide rapidly into an outer large and an inner small cell, the former further dividing into two.

5. Chondrus-type. (*Phyllophora Brodiæi*, *P. membranifolia*, *P. rubens*, *Chondrus crispus.*) Growth in length takes place by dichotomously branched rows of cells, the outermost of which divide by anticlinal and periclinal walls. No conducting hyphæ nor reserve-system. The cells in the interior part of the thallus are greatly elongated and united by pores, and form a conducting system.

6. Sarcophyllis-type. (*Sarcophyllis edulis*, *Furcellaria fastigiata.*) The mode of growth is the same as in the last type. Both conducting and reserve-hyphæ occur. The assimilating system consists of dichotomously branched rows of cells, each of which is connected with one or each side by a pore.

* SB. Bot. Sällsk. Stockholm, Sept. 23, 1885. See Bot. Centralbl., xxvi. (1886) p. 86. Cf. this Journal, v. (1885) pp. 684, 841; *ante*, p. 109.

Lithoderma and Hildenbrandtia.*—Herr R. Wollny has found *Lithoderma fluviatile* for the first time in Germany, and describes the structure of the unilocular sporangia; he also gives a fuller description of the marine *L. maculiforme*.

The frond of *Hildenbrandtia rivularis* he finds to be composed, not of a uniform mass of cells, as usually described, but of closely packed filaments quite distinct for their entire length.

Laminariaceæ of Japan.†—Herren F. R. Kjellman and J. V. Petersen describe several new species of *Laminaria*, *Ecklonia*, and *Alaria* brought from Japan by the Vega expedition, of which *L. angustata* represents the highest type yet discovered, with strongly localized sori; also the new genus *Ulopteryx*—of which the only species has been hitherto known as *Alaria pinnatifida* Harv.—with the following diagnosis:—Radix fibrosa; stipes alatus, alis demum latissimis, undulato-plicatis, soriferis; lamina cryptostomatibus prædita, costata, pinnatim ramosa; soris in alis stipitis dilatatis expansis, zoosporangia elongato-ellipsoidea vel subclavæformia inter paranemata lineari-clavæformia unicellularia dense stipata fovens.

Vaucheria sessilis.‡—M. E. Dewildeman describes a singular form of this species, parasitic on leaves in a spring, in which some of the filaments branch copiously at the extremity, the thick branches interweaving into a kind of ball. These filaments were always barren.

Auxospores of Cocconema and Navicula.§—M. P. Petit describes the mode of formation of the auxospores of *Cocconema Cistula* and *Navicula crassinervia*. He regards it as a process of simple asexual reproduction, never accompanied by any fusion of two masses of protoplasm. It is simply a case of regeneration of the frustules due to protoplasmic activity.

Hoops of Diatoms.‖—Dr. J. D. Cox supports the view that the hoops of diatoms are formed all at once out of the living contents of the frustule, and not by accretions upon the edge. The most noticeable difference between the hoops of different species of diatoms is that some are hyaline, while others are elaborately figured and ornamented with markings more or less resembling those of the valves. These latter are persistent, forming a permanent portion of the structure of the diatom, of which *Isthmia nervosa* and *Biddulphia pulchella* are familiar examples. The hyaline hoop seems usually to belong to the free-swimming forms, and those closely parasitic species in which a single frustule alone remains sessile upon and closely adherent to a larger alga or other support. A favourable illustration is afforded by *Aulacodiscus Kittoni*.

The normal form of this diatom is a convex disc with four short

* Hedwigia, xxv. (1886) pp. 1-5 (1 pl.).

† Kjellman, F. R., and Petersen, J. V., Vegaexped. vetensk. iakttag., iv. (1885) (2 pls.). See Bot. Centralbl., xxv. (1886) p. 327.

‡ Bull. Soc. Belge Micr., xii. (1886) pp. 66-8 (1 pl.).

§ Bull. Soc. Bot. France, xxxii. (1885), Session Extraordinaire, pp. xlviii.-li. (1 pl.).

‖ Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 33-7 (2 figs.).

but large processes, from which run to the centre conspicuous double lines of large areolæ, giving to the valve the well-known appearance of being marked with a cross, the ends of which end in the hollow side of the crescent-shaped processes. In the two valves these are not opposite each other, but alternate; and so long as two or more frustules remain in a temporary filament, they are interlocked by each process fitting into the hollow between those of the neighbouring valve. The hyaline hoops are divided by well-defined sutures into five, six, or more parallel bands or rings. The corrugated appearance of the hoop is an optical illusion, as is shown by the fact that the hoops slide over each other when the new frustules separate after the self-division of the parent. The most noticeable characteristic of these hoops is that the sutures are not continuous lines going quite round the shell; but at one place they curve sharply upward towards the valve, so that a tooth from the next outer division of the compound hoop cuts through its neighbour. These teeth alternate upon different sides of the shell; and if the hoop be divided upon the lines of these sutures, it will be found to be made up of a connected series of imperfect rings or bands with a projecting tooth upon the edge, and with the curved ends of the band separated by a space into which would fit a similar tooth upon the adjacent band of the hoop. The direction of the teeth has a fixed relation to the valve to which each hoop is attached, uniformly pointing towards it.

When the fission of the parent diatom is complete, and the two new frustules slide apart, the hoops have ripened so that the sutures between the bands open at the slightest touch. The division of each band by the tooth of the neighbouring one allows it to spring open, and the frustule (or pair of frustules ready for separation) is thus freed from the hoops, which fall to pieces of themselves. This mechanism Dr. Cox believes to be designed to facilitate the escape of the new diatoms from the shell of the old one. Similar structures are found in other genera of the family.

Division of Stephanodiscus Niagaræ.*—From observations of this diatom, Mr. C. M. Vorce confirms the conclusions of Dr. J. D. Cox† with regard to the hoop. By examining continuous series of gatherings the entire process of division may be seen. The first change observed is the widening of the connecting zone or hoop. The box of the frustule becomes in consequence deeper, until it is often as deep as it is wide; and at the same time the endochrome increases in quantity. About this time there is seen an extremely fine line of division crossing the centre of the frustule in the middle of the central mass of endochrome, almost invisible at first, but gradually becoming more distinct, and at first soft and flexible. Later it becomes doubly clear across the frustule, and begins to exhibit indications of the future spines of the new valves. The frustule has now become double, composed of two frustules, each of which has its outer valve thick and strong with long spines, and its inner new valve thin and fragile,

* Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 139–41 (4 figs.).
† See preceding notice.

with only rudimentary spines. The endochrome in each of the frustules is disposed as it was in the original frustule before division began. As growth goes on in the new valves they become thicker, and separate from each other further and further, being apparently pushed apart by the growth of the lengthening spines, until finally they are sometimes half as far apart as the width of the original frustule. The hoop of the parent frustule goes on widening to accommodate this growth, until, when the two new frustules are completely grown, they are ready to separate, and to repeat the process each for itself. One or both of the frustules now drops out of the hoop, and it is not uncommon to find the wide hoop with one frustule attached and one gone. The new valve is in this species clearly formed by the deposition of silex in or upon a membrane previously formed, and not by growth along an edge.

Finer Structure of certain Diatoms.*—Messrs. E. M. Nelson and G. C. Karop find that on examining certain diatoms with the finest oil-immersion objectives, and under conditions of illumination such as are absolutely essential if the full aperture, and therefore resolving power, of these glasses is to be utilized, some details of structure are brought into view which are otherwise quite invisible, and, as far as they know, have not hitherto been correctly described or properly figured.

1. *Coscinodiscus asteromphalos.* This diatom, although consisting of a single siliceous membrane, has a double structure, viz. coarse and fine areolations, the latter within the former. The coarse areolations are for the most part circular in outline, and the intervening silex is thick. Inside these areolations is a most delicate perforated membrane, the outermost row of perforations being much larger than the rest. This membrane is so thin and fragile that it is often broken out, and when this is the case the coarse areolations appear to have a crenated edge.

2. *Isthmia nervosa.* This is similar in construction to the above, having a single membrane with a twofold structure, a fine perforated membrane inside coarse areolations. The coarse areolations in this diatom are very large, and the silex correspondingly thick. At the same time the inner membrane is excessively thin and delicate as in *C. asteromphalos.* The perforations are large and irregular in shape around the margin, but smaller and circular in the centre. A broken areolation is figured to show the fracture passing *through* the perforations.

3. *Triceratium favus.* This diatom is very similar to the preceding. The coarse areolations are hexagonal in form and very deep. At the bottom of these is a delicate perforated membrane, the perforations being circular and arranged for the most part in rows. A figure is given showing a fracture passing through the minute perforations, the resolution of which may be considered one of the most crucial tests for the Microscope of the present day.

4. *Eupodiscus argus.* This diatom differs from the above, inas-

* Journ. Quek. Micr. Club., ii. (1886) pp. 269–71 (1 pl.).

much as it possesses two separate membranes, one containing the coarse and the other the fine areolations. The outer is a strong, coarsely-marked structure, the areolations being for the most part circular or oval in outline. The intervening silex is granulated on the exterior, and has a brownish colour by transmitted light. With reflected light, however, it appears white and sparkling, not unlike loaf-sugar. The interior membrane is very transparent and covered with minute perforations (only lately discovered, and which have been called *tertiary* markings). But in addition to these are what have long been known as the *secondary* markings, viz. white bright spots, which are arranged in rows radiating from the centre. These secondary markings must not, the authors consider, be regarded as perforations, as they have not found an instance of a fracture passing through them.

Another figure shows the secondary and tertiary markings on the interior membrane, as seen through the coarse areolations of the exterior membrane. The best way of examining the secondary markings is to use a 1/2 or 4/10 objective, with a lieberkühn, the specimen mounted dry, with the concave side uppermost. The tertiary are more difficult to see, and will require a higher power.

The fracture passing through the perforations in a valve of *Pleurosigma angulatum* is also shown. This diatom has but one membrane, and only one kind of perforations. To show this properly a lens must be very well corrected, and have its glasses very perfectly centered.

Lichenes.

Gonidia of Lichens.*— Dr. K. B. Forsell replies to Zukal's strictures in his 'Flechtenstudien'† on the author's views on the nature of the connection between the algal and fungal elements in lichens, and defends his statement in his work on the Glœolichens,‡ that Zukal has in many cases assumed, without sufficient evidence, a genetic connection between algæ and gonidia, and has hence been led to incorrect conclusions.

Fungi.

Symbiosis in the Vegetable Kingdom.§—Prof. R. Hartig confirms the account given by Frank,‖ of the occurrence of mycorhiza (*Rosellinia quercina*) on the roots of the oak. He considers, however, Frank's statement that many Cupuliferæ depend entirely on the mycelium of fungi for their nourishment as too absolute. It is not unfrequently entirely wanting; and, especially at the period when the trees are taking up the largest quantity of water and nutrient substances, the newly formed apices of the roots are entirely free from the fungus, which attacks them only in autumn and winter.

* Flora, lxix. (1886) pp. 49–64.

† See this Journal, *ante*, p. 112.

‡ Ibid., *ante*, p. 485.

§ SB. Bot. Verein München, Nov. 11, 1885. See Bot. Centralbl., xxv. (1886) p. 350.

‖ See this Journal, v. (1885) p. 844.

Mycorhiza of the Beech.*—Dr. P. E. Müller confirms Frank's observations † with regard to the mycorhiza on the young roots of the beech. He finds it especially in dry sandy soil exposed to the sun, where there are few earthworms, and where the soil has in consequence become exceedingly compact and hard. In such situations the lower roots of the beech trees die off, and they are nourished entirely by a reticulation of smaller roots near the surface. The ground becomes covered with a layer of dead leaves which is converted into humus by the attacks of fungi, rhizopods, &c. The finer roots of the beeches gradually approach the surface, and at length penetrate this layer, and the fungus-mycelium with which they become invested acts as a saprophyte, and conveys to its host the soluble humates and other substances formed in the layer of decaying vegetable matter.

Vitality of Spores of Parasitic Fungi.‡—Dr. A. B. Griffiths has experimented in the following manner: A quantity of spores of *Peronospora infestans* (potato-disease) were taken from a crop of diseased potatoes. These spores were then placed in a porcelain mortar along with about 5 grms. of a mixture of calcium sulphate and calcium carbonate, which were thoroughly mixed together. This mixture was then placed in a small oven always kept at a temperature of 35° C. (dry heat). After the spores had been dried up with these mineral substances (which principally constitute the dust found in the atmosphere) for two months, they had not lost their vitality, for in the space of three days after "sowing" they began to penetrate into the mesophyll of the leaves (of a potato plant) through the stomata. The leaves of *Solanum tuberosum*, along with dried two months' old spores of *Peronospora*, were kept in a warm, moist atmosphere, such conditions being favourable for the development of these spores. On the fifth day after "sowing" there was a mycelium which had ramified through the tissue of the leaf, and there was also observed the production of conidia-bearing branches making their appearance through the stomata of the leaves. After six months of dry heat another portion of the dust was examined under the Microscope, mounted in water as before. The cellulose wall of the spores appeared rather shrivelled. Their vitality had not disappeared, for after seven days from "sowing" on the potato leaf there was a rapid development of hyphæ, &c.; thus showing that even after the spores had been dried up for six months as dust, they were capable of germinating, and each organism leaving its life-history upon the host-plant.

Again, after being in a dried state for ten months, it was found that the spores had lost their vitality. They did not germinate upon the leaves of *Solanum*, not after being in contact with the leaves in a warm and a damp atmosphere for a month or six weeks. Under the Microscope the spores were seen to be shrivelled up and their protoplasm dead.

* Bot. Centralbl., xxvi. (1886) pp. 22–6 (5 figs.).
† See this Journal, v. (1885) p. 844. ‡ Chem. News, liii. (1886) pp. 255–7.

From this investigation it will be seen that the spores of *Peronospora infestans* may be dried up in an atmosphere and preserved as dust for the space of eight months without the loss of their vitality, and will germinate again when favourable circumstances are offered for their development.

Formation of Lignin in Fungi.*—According to Dr. C. O. Harz, the statements hitherto made with respect to true lignification in Fungi rest on erroneous observation. Experiments on a large number of species with anilin-sulphate and with phloroglucin and hydrochloric acid, failed to detect any lignin reaction. The hard cortical shell of *Elaphomyces*, on the contrary, with its projecting knobs and warts, is stained yellow by the former, bright red by the latter reagent, thus showing an instance of true lignification in a fungus.

In addition to his previous detection of lignin in *Elaphomyces cervinus*, Dr. C. O. Harz † now finds it in the sclerenchymatous fibres of the capillitium of several species of *Bovista*, as determined by phloroglucin and hydrochloric acid. The lignin of these fungi appears to be more readily soluble in potash and soda than that of the higher plants. In a large number of fungi examined no trace of it could be found.

Fungi which cause decay in timber.‡—Mr. P. H. Dudley finds that the fungus most destructive to railway sleepers, planks, and bridge-timbers made of yellow or Georgia pine (*Pinus palustris*) is *Lentinus lepideus*. The mycelium secretes fluids possessing acid reactions, which readily soften the thin-walled tracheides, causing their dissolution, and producing abundance of crystals of oxalate or phosphate of lime, or sometimes carbonate. As soon as the tracheides are softened by the action of this fungus, larvæ perforate and consume them, leaving the harder thick-walled cells in the condition of a series of shells. Abundance of Schizomycetes were found in connection with it.

Fungus-bulbils. §—Herr H. Zukal has observed the bulbils already described by Eidam ‖ in five fungi, viz. *Dendryphium bulbiferum* n. sp., *Helicosporangium coprophilum* n. sp., *Haplotrichum roseum* Lk., *Melanospora fimicola* Hans., and a *Peziza*. From these bulbils only conidial forms are, as a rule, developed. In two cases, however, the bulbils were transformed into fructifications, and Zukal therefore regards them morphologically as these organs in an undeveloped condition. In the fructification of some Ascomycetes the bulbil-forms may occur as a normal stage of development. The so-called sclerotia of *Penicillium glaucum* are probably modified bulbils.

* SB. Bot. Verein. München. May 13, 1885. See Bot. Centralbl., xxiii. (1885), p. 371.

† SB. Bot. Verein München, Jan. 13, 1886. See Bot. Centralbl., xxv. (1886) p. 386.

‡ Journ. N. York Micr. Soc., ii. (1886) pp. 36–7.

§ Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxvi. (1886) pp. 123–36 (1 pl.).

‖ See this Journal, iv. (1884) p. 421.

Octaviania lutea.*—Herr R. Hesse describes under this name a new fungus found on decaying beech leaves in Hesse.

Sphærosoma fragile.†—Under this name Herr R. Hesse describes a new underground species, and takes the opportunity of revising the position of the genus, which he places, with Tulasne, among the Discomycetes, near to *Rhizina*, and not, as proposed by Berkeley and Broome, among the Tuberaceæ. It is altogether destitute of perithecia.

Uredineæ of Illinois ‡—Dr. T. J. Burrill gives a complete list of the Uredineæ hitherto found in Illinois. It includes 20 species of *Uromyces*, 48 of *Puccinia*, 5 of *Phragmidium*, 1 of *Ravenelia*, 1 of *Gymnosporangium*, 1 of *Cronartium*, 4 of *Melampsora*, 2 of *Colcosporium*, 1 of *Uredo* (isolated), 2 of *Cæoma* (isolated), 41 of *Æcidium* (isolated), and 2 of *Rœstelia* (isolated).

Protophyta.

Mastigocoleus, a new genus of Sirosiphonaceæ. §—Under the name *Mastigocoleus testarum* Herr G. Lagerheim describes a new species and genus of Phycochromaceæ found attached to the shells of marine molluscs, the first-observed marine species of Sirosiphonaceæ. The diagnosis of the genus is—Trichomata vaginata, ramificatione vera irregulariter ramosa, cellulis vegetativis uniseriatis cylindricis composita. Rami biformes, partim cylindrici, partim flagelliformes. Heterocystæ singulæ (rarissime binæ) terminales vel laterales, nunquam intercalares. Multiplicatio hormogoniis et cellulis chroococcoideis. Sporæ ignotæ. Contentus cellularum homogeneus. The filaments appear to secrete an acid which dissolves the lime of the shell. The genus seems to have the greatest affinity with *Mastigocladus* Cohn, found in thermal springs, but differs in its terminal or lateral heterocysts and uniseriate branches.

Presence of Micro-organisms in the Living Tissue of Healthy Animals. ‖—Herr G. Hauser has subjected this question to fresh examination, with the following results:—In the living tissues and tissue-fluids of healthy animals he finds neither pathogenic nor any other description of bacteria. When all kinds of Schizomycetes are excluded from animal tissues preserved in oxygen, hydrogen, or carbonic acid, in water or a nutrient solution, but the access of atmospheric air permitted, they undergo a similar retrogressive metamorphosis to that of the tissues in the living body, which decay in consequence of simple nutritive disturbances without the action of

* Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) pp. 255-61 (1 pl.).
† Ibid., pp. 248–54 (1 pl.).
‡ Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 93–102.
§ Notarisia, i. (1886) pp. 65–9 (1 pl.).
‖ Arch. f. Expér. Pathologie u. Pharmakologie, xx. p. 160. See Naturforscher, xix. (1886) p. 94.

the bacteria of necrosis. The products of decomposition which result from the destruction of tissue independent of any action of bacteria have no pathogenic properties.

Tenacity of Life in Micrococci.*—MM. Perroncito and Airoldi experimented on *Micrococcus ambratus*, the cause of pneumonia in calves, and on the *Pneumococcus* of the horse, in order to ascertain the relative lengths of time for which they could be kept alive. On one glass plate was spread some pure culture of *M. ambratus;* and on a second plate a similar culture, to which was added some sterilized water. These were then placed in a water-bath, at a temperature of 35° C. Each day a small portion was taken from each culture and sown in a tube containing gelatin. So long as the *Micrococci* remained alive, they grew and formed small characteristic spots. *Micrococcus* from the pure culture remained alive at the sixteenth day; the other was dead on the thirteenth day. *Pneumococcus*, treated with sterilized water, died very much sooner—on the tenth day. Heated to 50° C., in the dry state, both were dead at the end of an hour. The authors conclude that *Micrococcus* resembles the non-spore-forming *bacteria* more than does *Pneumococcus*, so far as resistance to high temperatures is concerned.

Behaviour of the Spores of the Schizomycetes to the Anilin-dyes.†—Herr H. Buchner had already pointed out that spores of *Bacillus subtilis* which did not take up any anilin-stain on simply drying on the cover-glass, did so energetically when killed by heating in the dry or moist way, or by treatment with pure concentrated sulphuric acid or strong potash-ley. The same phenomenon occurs also in the sporiferous distemper-filaments if these are dried on the cover-glass, then slowly passed through the flame, moistened for a few seconds with concentrated sulphuric acid, and finally washed with water and stained by gentian-violet. The filaments then have a distinctly septated appearance, the separate cells are either somewhat thick and slightly stained or of normal width and strongly tinged, the spores intensely so. The remarkable fact is then seen that the spores, which previously lay in the vegetative cells of the filament, are driven out of them by the action of the sulphuric acid, some of them lying free by the side of the cells, some still adhering to their side-walls, in the act, as it were, of escaping. Precisely the same appearance is seen in *Bacillus subtilis*, which the writer regards as a fresh confirmation of the morphological identity of these two forms.

The author explains this behaviour of the spores of the Schizomycetes towards anilin-pigments, on the one hand by the well-known fact that living protoplasm does not take up any pigment, on the other hand by his experiments, which show that the power of germination of the spores is destroyed by the same degree of heat which brings about their staining. He does not, however, agree with the hypothesis of Koch that the strongly refringent substance of the spores is

* Arch. Ital. Biol., vii. (1886) p. 341.

† SB. Gesell. f. Morph. u. Physiol. München, 1885, 4 pp. (1 fig.). See Bot. Centralbl., xxvi. (1886) p. 55.

oil, but considers it probable that it does not differ in chemical properties from the protoplasm of the vegetative cells.

Cultivation of Bacteria and Cholera-bacillus.*—Dr. L. Curtis has repeated Koch's experiments on the "comma-bacillus," and agrees generally with his conclusions that it is unlike any other form, that it is peculiar to cholera, and is the cause of the disease. Dr. Curtis states further that the disease is not contagious; it is only by the bacillus gaining access to the intestinal canal that the disease is caused. The bacillus does not grow in acids; consequently when digestion is active, the chances of taking cholera are small. It is only at the times when the stomach has ceased to act, as during attacks of indigestion from whatever cause, that cholera comes on. The bacillus grows freely in water and on damp surfaces. It forms no spores, and is not found in the blood; inoculation is therefore useless. The germ is easily killed, as by a 10 per cent. solution of carbolic acid in twenty-four hours, by corrosive sublimate in a few minutes, or by superheated steam in half an hour. Cold checks its growth, but does not kill it.

New Bacterium.†—Under the name *Bacterium tortuosum* Herr H. Zukal describes a form found in a tank, the water of which was at first coloured quite green by *Euglena*, but which lost its colour after the appearance of the masses of bacteria. The rods possessed a cilium at each end, and combined into zoogloea-colonies, which assumed a ribbon-like appearance as the rod passed into the filiform form; these ribbons were 14–20 μ broad and rolled up like shavings. On the fourth day after the swarming condition a great part of the spiral bands had formed spores; but the germination of these was not observed. Several new species of Fungi and Myxomycetes are also described.

Bacillus Malariæ.‡—The observation first made by Laveran some years ago as to the existence of an amœboid organism in the blood of persons suffering from malarial fevers, and which disappears under the influence of quinine, has comparatively recently been confirmed by Drs. E. Marchiafava and A. Celli.§

The parasite is an extremely minute amœboid organism found free in the blood, or in the interior of the red corpuscles or attached to them. In a certain stage of its development it possesses from one to three or four flagella, and is endowed with active movements. This form is, however, but rarely encountered. In addition to the above-mentioned facts, the organism is frequently found to contain granules of black pigment, such as has been ofttimes noted in the blood of patients suffering from malaria. But little beyond these is known of the life-history of the parasite, although Drs. Marchiafava and Celli have produced malarial paroxysms in persons previously

* Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 142–50.
† Verhandl. K. K. Zool.-Bot. Gesell. Wien, 1885, pp. 333–42.
‡ Cf. Science, vii. (1886) pp. 297–9 (28 figs.).
§ Fortschr. d. Med., 1885, pp. 339 and 787.

free from the disease by injecting blood which has been found to contain the organism, into their veins, and subsequently verifying the result after the onset of the intermittent fever.

The publication of the researches of Marchiafava and Celli has provoked a reply from Prof. C. Tommasi-Crudeli,* who is of opinion that they have mistaken for the cause of the alteration of the red corpuscles, the effect of another cause. No pathologist, he says, would fail to recognize in the alterations depicted by them a retrogressive metamorphosis of the red corpuscles, and no zoologist would be able to recognize from these illustrations the progressive development of an animal parasite; while the breaking up which Prof. Golgi, who has more recently corroborated the existence of the *plasmodium malariæ*, calls segmentation, is cited as being the best of proofs of a retrograde change. The illustrations of the plasmodium are, says Tommasi-Crudeli, identical with those given by Rollett to show the effect of an electric shock on the red corpuscle of a frog.† The objections to the granules are that they do not move, and that they have not been seen to develope into plasmodia.

The extensive reasons offered against the plasmodium are that hitherto no general progressive infections have been found to be caused by animal parasites, but on the contrary by vegetable ones; and, once admit that malaria is due to a living organism, it follows that it must be vegetable in nature, for how could an animal existence survive through long periods of time, buried deep in the earth, developing into activity as experience has shown of malaria frequently by accident? And yet we know that this has happened over and over again, even with vegetable organisms of much higher development than the Schizomycetes.

Prof. Tommasi-Crudeli finally confirms the opinion originally promulgated by him, that the malarial ferment is a Schizomycete such as was described by himself and Klebs in 1879.

Pneumococcus of the Horse.‡—M. E. Perroncito investigated the cause of "croupal pneumonia" in horses, and found in the diseased lung (not, however, gangrenous) by means of sections stained with 1 per cent. methyl-violet, large spherical or ovoid micrococci, sometimes solitary or in twos, threes, and in even larger groups; these were frequently surrounded by a gelatinous capsule which does not stain. These organisms are *Bacterium pneumoniæ cruposæ;* their diameter is about $1 \cdot 5\,\mu$.

He obtained cultures on gelatin, and inoculated rabbits, horses, &c., which sooner or later died from lung disease, and from the lung he obtained bacteria similar to those injected.

From various experiments the author concludes that the pneumococcus of the horse differs from that of man, (1) in that it is pathogenic in rabbits and other animals; (2) in that the methods used for

* Atti R. Accad. Lincei, ii. (1886) pp. 223–7.
† Hermann's Physiologie, Bd. ii. Th. i.
‡ Arch. Ital. Biol., vii. (1886) pp. 343–4.

colouring the gelatinous capsule are (at present, at any rate) insufficient in the case of the pneumococcus of the horse.

Microbe of Rabies.—Mr. G. F. Dowdeswell considers that he has found the microbe which appears clearly to constitute the virus of this disease. It is a micrococcus, not very minute, and of the usual form. It stains, however, with some difficulty; and this accounts for its having hitherto escaped observation. In the cases of dogs which he has as yet examined, its principal seat is evidently the central canal of the spinal cord and medulla oblongata; thence it pervades the other tissues of the central nervous system, occurring (sometimes in vast masses) around the walls of the blood-vessels, and in some cases within the vessels amongst the red blood-corpuscles. He found it in the cortex of the hemispheres, but in very small numbers, and, so far, only in the perivascular and pericellular lymph spaces. In the cerebellum it was not found at all, nor in the salivary glands. It does not stain by hæmatoxylin, either with or without a mordant, as asserted by Prof. Fol. Neither does it occur within the nerve-fibres, as he states; and lastly, it is fully three times the dimensions which he gives. It does not occur in the same situation, treated by the same methods, in normal animals. In the one case of a rabid dog, which Mr. Dowdeswell had examined to control his previous observations, the tissues were placed in alcohol so shortly after death as to preclude the possibility of the occurrence of septic organisms. In addition to which, all saprophytes, as far as yet observed, stain very readily with the usual anilin dyes, which this microbe does not.

Rabies.*—Prof. H. Fol has, by means of a second culture of his microbe of rabies, succeeded in inducing madness in the animals under experiment. He has sent cerebral matter of a rat thus inoculated to Pasteur, who has confirmed the statement that madness is transmitted to animals inoculated with it. Latterly Fol has experimented on the dog, in which the symptoms are more characteristic. The microbe shows itself under a constant form.

The best way of obtaining a culture is to grind down the cerebellum and salivary glands with carbonate and phosphate of potash, then to filter through a "Chamberland bougie." The most potent rabies virus is in the brain and spinal cord; it is less so in the salivary glands, and in the blood is completely absent. The propagation, then, is not carried on by the blood, but is transferred by nerves and by lymphatic vessels.

Hüppe's Methods for the Study of Bacteria.†—Dr. F. Hüppe's exhaustive work on this subject commences with a brief statement of the various classes of bacteria, followed by the principles on which sterilization depends, together with the various methods, including that of discontinuous or intermittent sterilization. The various forms of bacteria are next described, with the method of

* Arch. Sci. Phys. et Nat., xv. (1886) pp. 414–5.

† Hüppe, F., 'Die Methoden der Bakterien-Forschung,' 3rd ed., 244 pp., 40 figs. and 2 pls. (8vo, Wiesbaden, 1886.)

observation of unstained and stained bacteria. Considerable space is devoted to the methods of staining the bacillus of tuberculosis, and especially its spores. The method of treating sections of tissue for the purpose of showing bacteria, and the various culture methods and materials are given; and something is said of saprophytic and parasitic bacteria. The work is illustrated by good woodcuts and two lithographic plates.

MICROSCOPY.

a. Instruments, Accessories, &c.*

Watson-Crossley Microscope.—This (fig. 113) is a combination of the Oblique Illumination Microscope of Messrs. Watson (see this Journal, Vol. I., 1881, p. 516) and the Swinging Tail-piece Microscope with illuminating prisms, of Mr. E. Crossley (ibid., p. 653).

The peculiarity of the former instrument, it will be remembered, consisted in the body-tube being set laterally on the limb, the latter being made to incline with the stage, on a horizontal axis in a line with the object, the mirror remaining fixed. By this means, and by the power of rotating the whole instrument round the mirror, illumination in all altitudes and azimuths could be obtained, without moving the eye, the light from the mirror remaining constantly upon the object.

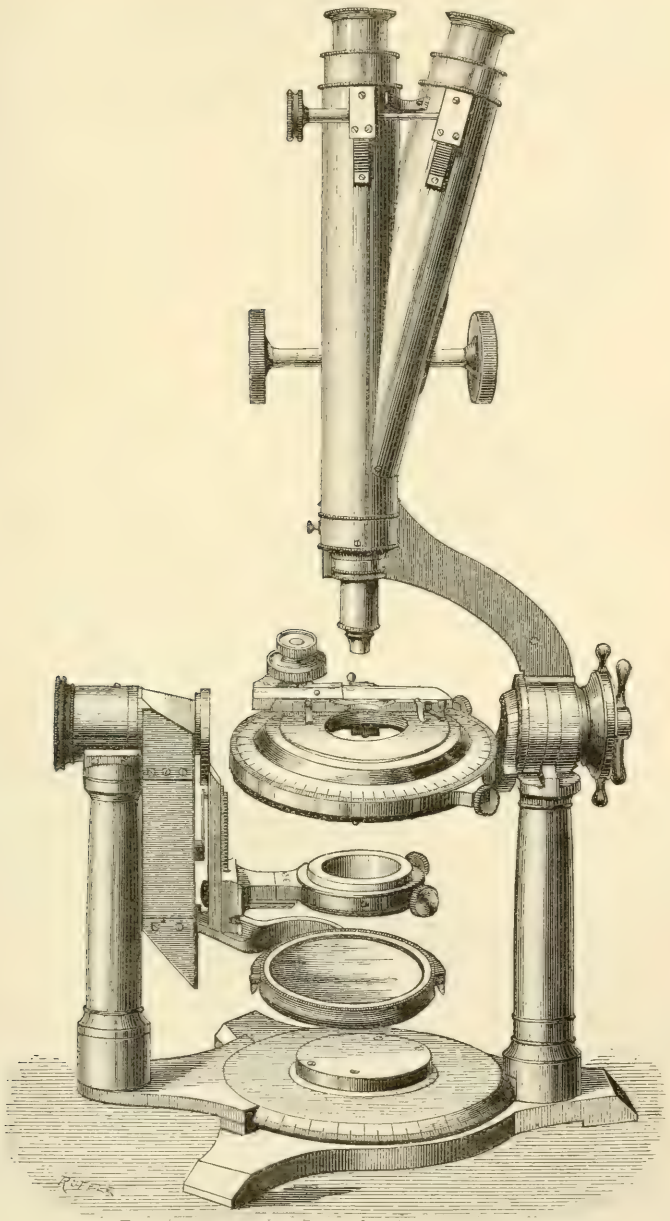
The second instrument was provided with a hollow swinging tail-piece, enclosing three prisms, by which the light from the lamp passing into the hollow trunnion axis was projected down the arm and thence upon the mirror; thus no change of the Microscope on its horizontal axis affected the illumination which remained constantly on the object.

The speciality of the new form consists in the above two ideas being combined. It would be difficult to do this if the tail-piece were retained in its ordinary place, as the one form requires much solidity in the axis on which the limb inclines, while the other necessitates the axis being made hollow. The swinging tail-piece with the substage and mirror is therefore separated from the Microscope and attached to a pillar on the opposite side of the base. As in the first-mentioned form, the mirror (detached from the tail-piece) can be fixed to the base. The stage also inclines on its axis as well as the limb with the body-tube.

Thus the observer has the choice of obtaining oblique light in one and the same instrument, either (1) by inclining the body-tube over the fixed mirror, or (2) by using the mirror on the swinging tail-piece.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

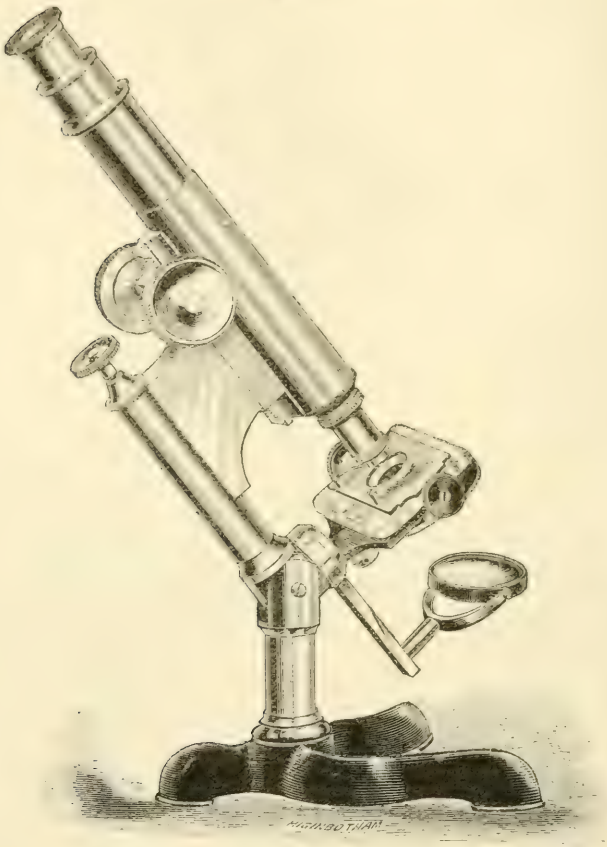
FIG. 113.



WATSON-CROSSLEY MICROSCOPE.

Bausch and Lomb Optical Co.'s Physician's Microscope.—The special features of this instrument (fig. 114) are the fine adjustment (described in Vol. II., 1882, p. 683), the cradle-joint for inclining, and the glass stage. The latter rests on a forked support and could be made to give in a different form one advantage of Mr. Nelson's divided

FIG. 114.

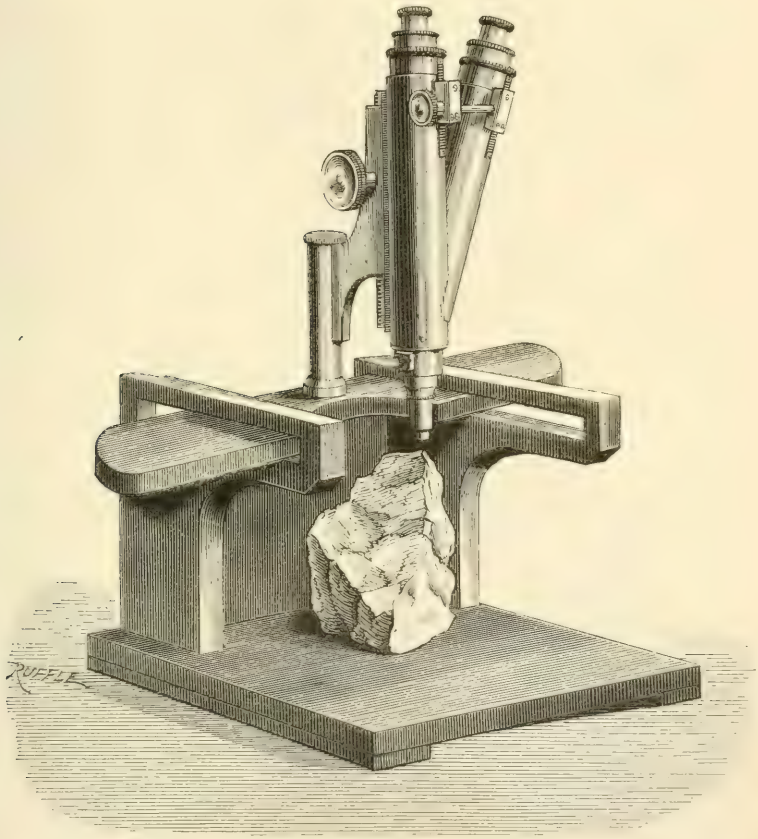


stage, as with glass the position of the illuminating apparatus would be readily seen. The slide-carrier would, however, require to be altered, so as not to impede the view beneath the stage. There is a removable substage and diaphragm.

The pillar and arm, in the original form, were marked so as to indicate the correct inclination of the body in the use of the camera lucida. The mirror is attached to a swinging tail-piece.

Beck's Mineral Microscope.—This (fig. 115) was devised by the late Mr. R. Beck for rapidly looking over large pieces of rocks. The body-tubes and pillar of a binocular Microscope are attached to a flat horizontal bar which is passed through longitudinal apertures in two

Fig. 115.



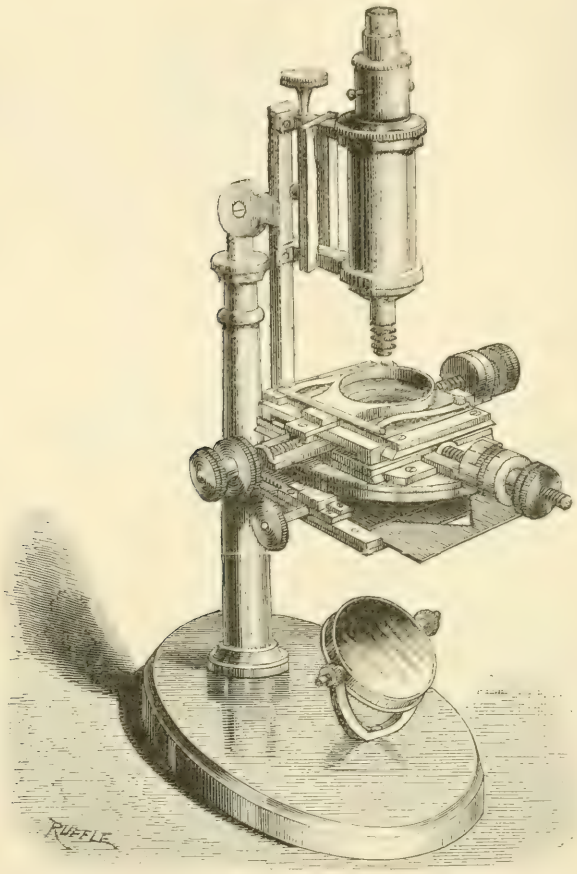
standards which rise from a large wooden base. The ends of the bar project sufficiently to allow of its being moved by the hands from side to side and from back to front, so that the Microscope can be passed over a large rock placed on the base. The latter is 11 in. × 10 in., and the bar is 6 in. above it.

Deutgen's Micrometer-Microscope.—This Microscope (fig. 116) was devised and constructed in 1845 by Herr H. Deutgen, of Groningen, for the physical laboratory of the University of that city.

The peculiarities are (1) the application of the Turrill system of mechanical stage, which had only then been recently invented by

Mr. Turrill in England; (2) the *two* screw stage-micrometers acting at right angles, so that measurements can be made in both directions, and (3) the variable diaphragm beneath the stage, consisting of two rectangular plates, each having a large V-shaped aperture, and so

Fig. 116.



arranged that a pinion at the side causes them to move together but in opposite directions, thus varying the size of the square aperture of the diaphragm from the full opening (1½ in.) to a minute hole.

The fine adjustment is by a direct-acting screw behind the body-tube, raising or lowering a stud to which is attached the support of the body-tube.

The stage has spring clips connected by a rod, to grip glass cells of special design.

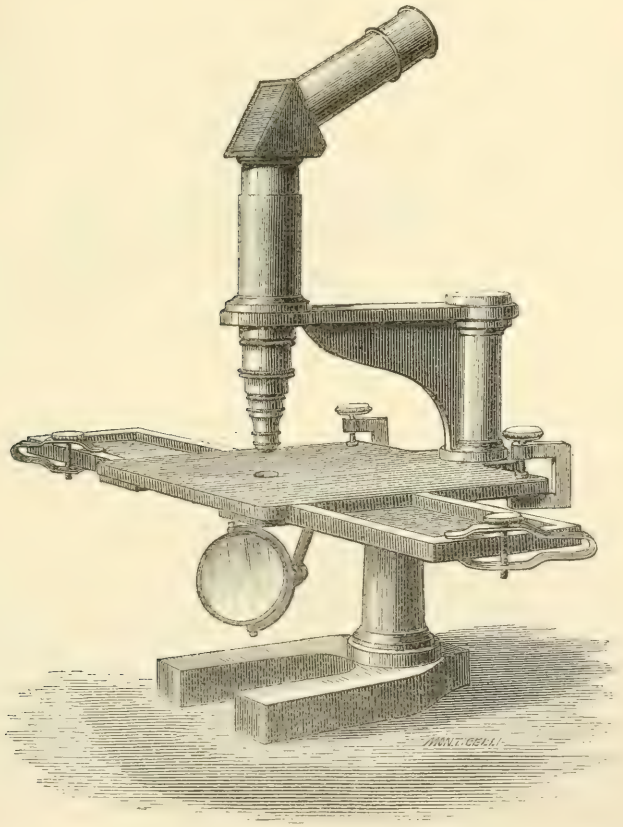
The question of duly balancing the instrument on its inclining

axis was wholly neglected in the design; and indeed the slender attachments of the body-tube with its focusing adjustment, the ponderous mechanical and micrometer stages, and the adjustable diaphragm on the long square bar indicate on the part of the maker a very imperfect estimate of the necessity of stability for the purpose he had in view.

Giacomini's Microscope with large Stage.—Signor F. Koristka, of Milan, sends us fig. 117 as showing the modifications which he has introduced into this instrument since its original design.*

The lateral "wings" by which the width of the stage is increased

Fig. 117.



to 40 cm. (wide enough to take sections of the entire human brain) are in the form of hollow trays, while the fine adjustment is now effected by an arrangement at the nose-piece acting similarly to the old form

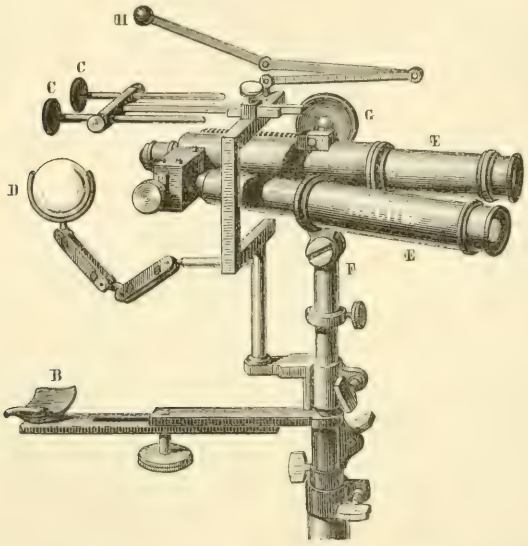
* See this Journal, v. (1885) p. 516.

of correction collar of an objective. The nose-piece consists of two tubes, the inner one being pressed upwards by a spiral spring encircling it; it is provided with two pins which travel in slots in the outer tube; a screw collar on the latter works against the pins, and thus controls the motion upwards or downwards of the inner tube.

Nachet's Corneal Microscope.—M. Nachet sends us fig. 118, showing his form of Corneal Microscope, which, unlike that by Schieck described Vol. IV. (1884) p. 954, has binocular body-tubes.

The body-tubes E E are attached to the standard F, which consists of three tubes sliding in one another and intended to be clamped to the table. The body-tubes can be inclined on a hinge joint. There is a coarse adjustment at G. The leather-covered pads C C form a rest for

Fig. 118.



the forehead of the person under observation, and B for his chin. They can be adjusted to different lengths. The little ball H is used as an object to be followed by the eye of the patient, so as to present different parts of the cornea to observation. D is a bull's-eye condenser. The screws on the standard are for adjusting the two arms in any desired position and for clamping the sliding tubes of the standard at any given point of extension.

The instrument is also adapted for examining aquaria, and surfaces of all kinds, the skin, &c.

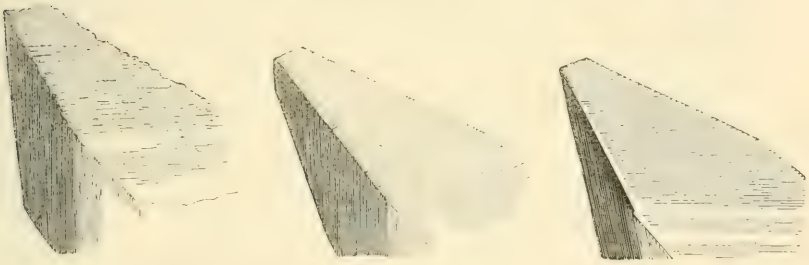
Use of the Microscope in the Mechanical Arts.*— Mr. G. M. Hopkins indicates the many uses which may be made of the Microscope in workshops, not only for making fine measurements and

* Central-Ztg. f. Optik u. Mech., vi. (1885) pp. 270–2 (10 figs.).

examining the quality of the work, but also in the selection of material and observing its behaviour under different conditions.

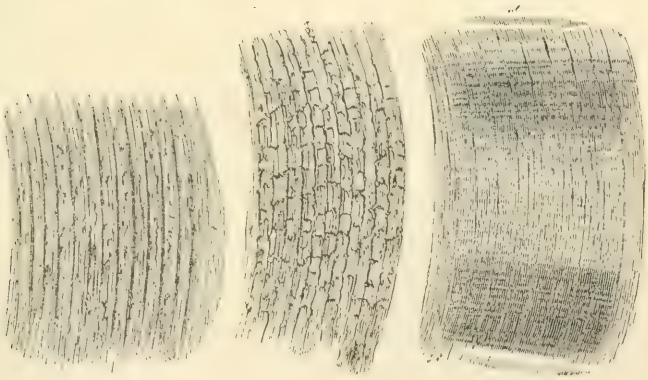
Thus the causes of the great differences in the efficiency of tools used in metal-working may best be detected and studied by the Microscope. The efficiency of the tool must depend not only upon the quality of the steel, but also upon the way in which the edge has been given to it. A tool sharpened upon a coarse grindstone is in reality grooved and notched, while one that has been smoothly ground

Fig. 119. Fig. 120. Fig. 121.



and finished upon a hone-stone shows a straight sharp edge; these characters are well seen with the Microscope, and are also betrayed by the surface of material worked by the tool. A coarsely ground tool (fig. 119) produces the furrowed and ridged surface of fig. 122;

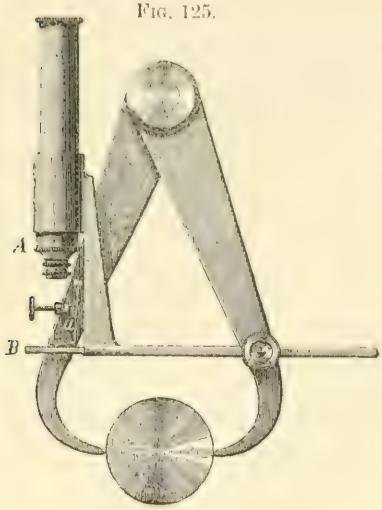
Fig. 122. Fig. 123. Fig. 124.



one that has been ground upon an emery wheel which does not run truly (fig. 120) works the surface shown in fig. 123, where the metal has been torn out and not cut by the tool, while fig. 124 represents the smoothly-cut surface worked by a well-finished tool (fig. 121).

Fig. 125 shows another purpose to which the Microscope can be applied in the workshop to obviate the difficulty often experienced in making accurate measurements with callipers. B is a bar with a micrometer scale, fastened to the right limb of a pair of callipers, and *a* is an index fastened to the left limb. The work having been calibrated in the usual manner, the position of the index upon the scale is accurately determined by means of the Microscope A which is also carried by the bar B; and it is clear that in this way a precision is secured which is quite unattainable by the ordinary methods of calibration.

Fig. 125.



Finally the Microscope can with advantage be used to criticize the efficiency of the emery wheel; for this there is no better criterion than an examination of the fine dust thrown off at the edge of the wheel. If the cement is not hard enough, the particles of emery are soon loosened and removed; if on the other hand there is too much hard

Fig. 126.

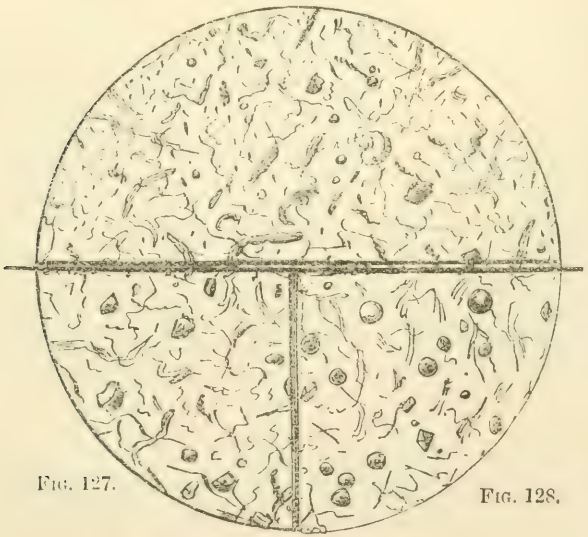


Fig. 127. Fig. 128.

cement, the emery will remain enclosed in it and the wheel will only do its full amount of work by the exertion of undue pressure. A careful examination of the dust especially with regard to the proportions of cement, emery, and iron or steel particles which it contains, will show without doubt whether the wheel is well made and is doing its work efficiently. Under the best conditions the grindings should consist mainly of iron or steel with few particles of emery and few spherules of molten metal; if there is much emery present, the wheel is wearing too rapidly; while the presence of much molten metal indicates that too much pressure is being exerted. Fig. 126 represents the dust from a good wheel; here there are only a few angular particles of emery, while the particles of metal are sharp and clean cut. Fig. 127 contains a large quantity of emery and only little cement, while the particles of metal are as in the previous case, and the wheel will wear out very quickly. Fig. 128 represents the dust of a wheel which contains too much cement. The great pressure necessary to make it cut was sufficient to fuse the particles of iron or steel.

Attached to the Königliche Technische Hochschule at Charlottenburg, Berlin, is a department for the preparation of microscopic sections where metals are cut, polished, etched, and mounted for the Microscope. With the sections are also to be obtained diagrams in one or more colours drawn to the scale of 50 : 1.*

The Microscope in the Workshop.†—Prof. W. A. Rogers in a paper read before the Boston Meeting of Mechanical Engineers, refers as follows to the use of the Microscope in the workshop :—

"In the ordinary operations of the workshop, the lathe and the planer are the primary tools, while the caliper, with the graduated scale, is the secondary tool. Let us take the most simple case. It is required to turn down a piece of metal to a given diameter. In order to make the assumed case as simple as possible, we will assume the required diameter to be an even inch. The caliper is set for this unit of length, either from a graduated scale or, more accurately, from an end-measure inch with parallel faces. The setting in the latter case is done by the sense of feeling. We thus introduce an additional element of complexity, since sight is at once the primary sense and the ultimate test of a given limit of extension upon which the workman must rely. When the market is supplied with graduated scales from which any required length may be taken by the sense of feeling, it will be in order to defend the practice of relying upon this sense as a final test in measurements of extension. As a differential test, it is both useful and accurate. As an absolute test it had better be abandoned. It is a makeshift at best. Assuming that the caliper has been set to an exact inch, the workman turns the piece of metal to the required size by a series of approximations with the ever-present risk of going beyond the required limit. During the final part of the operation he stops the lathe to test the

* Central-Ztg. f. Optik u. Mech., vii. (1886) p. 131.
† Cf. Engl. Mech., xliii. (1886) pp. 397-8.

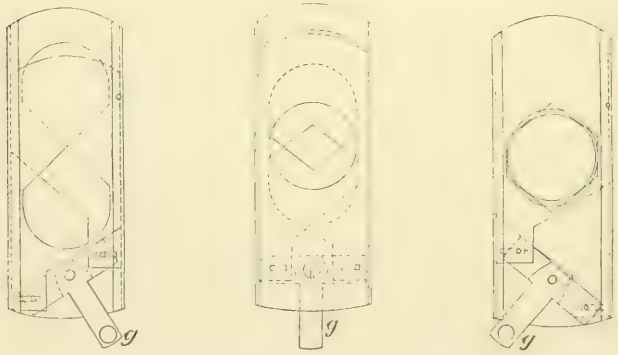
diameter with his caliper. He then takes another chip, stops, tries, starts, stops, tries, until the subtle and ever-varying sense of feeling satisfies him that he has obtained the correct diameter. But, after all, the uncertainty in the setting of the caliper remains, and this uncertainty is generally greater than that which would be found to exist in the comparative trials of the diameter. If, now, we increase the required unit, and especially if fractional increments are added, the problem of transferring a required length from a scale to a caliper becomes a most serious one.

"Only one other objection remains to be overcome. It is the common impression that the delicate adjustments of the Microscope which are continually demanded—especially the adjustment for focus—can only be made by the most delicate and sensitive means. No impression could be more erroneous. Give me a small lead hammer and I will set the top of my comparator to a given line in half of the time and with greater precision than it can be set by means of a screw movement. Give me a vertical movement by means of an eccentric disc and a long lever arm, and I will bring the surface of a plate weighing 100 lbs. into the focus of the objective quite as quickly and quite as accurately as a similar adjustment could be made in the hands of a professional microscopist."

Klönne and Müller's Diaphragm. — Herren J. Klönne and G. Müller have patented * an ingenious diaphragm shown in figs. 129–133.

It consists of two plates, each pierced with an aperture as shown in figs. 132 and 133. They are connected to a T-piece g by pins passing

Fig. 129. Fig. 130. Fig. 131.



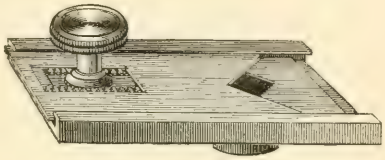
through the slots in the ends of the arms. This T-piece is attached to a frame sliding below the condenser, and just wide enough to allow of the plates moving backwards and forwards in grooves as the T-piece, turning on a central pin, assumes the different positions shown in figs. 129–131. In the first position the light is shut off, while in

* German Patent, Kl. 42, No. 34870, 26th August, 1885, 1 p. and 11 figs.

the last we have the full aperture. Any intermediate degree of illumination can be obtained; the illumination is made excentric by shifting the whole apparatus laterally.

An analogous device was constructed by Dollond, and is described and figured by Harting from a Microscope at Utrecht.* A practically identical form which we recently obtained in England, is shown in fig. 134, where two plates with V-shaped apertures are made to

Fig. 132. Fig. 133. Fig. 134.



move simultaneously in opposite directions by racks and a pinion. The aperture can thus be varied from a pin-hole to half an inch. Deutgen's Micrometer-Microscope (*supra*, p. 673) has the same form of diaphragm, which is however a fixture beneath the stage.

Now that the Iris diaphragm, however, in the form used by Messrs. Beck in their "Star" Microscope, can be made so cheaply, it would appear to supersede any of the forms of diaphragm above noted.

Lieberkühn Stops.†—Dr. G. W. M. Giles writes that during the process of examination and delineation it will be often found desirable to substitute direct for transmitted illumination, and to effect this change expeditiously he finds no appliance so useful as the old-fashioned but much-neglected Lieberkühn. To stop out the central rays of light he employs small discs of vulcanite, sawn out of a very thin piece of sheeting. By simply wetting them, these can be made to adhere to any part of the under surface of the slide, and can be shifted about if necessary with the tip of the finger, without removing the slide from the stage. By alternately employing direct and transmitted light, many details of structure can be learnt which could not possibly be made out by either alone, and it enables one also to fill in the natural colours in the finished drawing, which are quite lost by transmitted light.

Ross's Centering Glass.—This apparatus was designed by Mr. A. Ross for ascertaining whether stage diaphragms, illuminators, and other appliances are properly adjusted in the optic axis of the Microscope, and acts on the principle that when suitable lenses are inserted in the body, or superadded to the eye-piece at various positions, they

* Das Mikroskop, 1859, pp. 841–2 (2 figs.). † Sci.-Gossip, 1886, p. 121.

will give an extended conjugate focus to the object-glass, so as to convert the combination into a kind of telescope.

The apparatus (figs. 135 and 136) consists of a pair of plano-convex lenses mounted in a tube fitting in an adapter which is placed

Fig. 135.

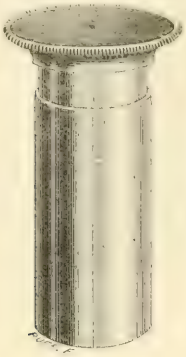
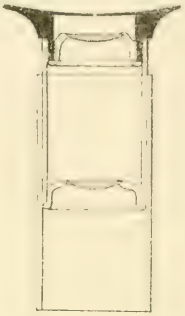


Fig. 136.



over the eye-lens of an ordinary eye-piece when the eye-guard is removed. A pin-hole diaphragm is fitted over the upper lens, and the combined focus of the two is about ½ in. To allow of adjustment for focus the lenses slide in the adapter, and when adjusted the eye-point (or "Ramsden" circle) can be focused and viewed through them.

The centering glass is used in conjunction with a cap, having a pin-hole aperture, fitting over the illuminator, so that the collimation of the two pin-hole diaphragms with the source of light will afford a ready method of adjusting the illumination exactly in the optic axis.

In practice, the pin-hole cap is first applied over the illuminator, and the image of the source of light seen through it is centered approximately with the ordinary eye-piece; the centering glass is then put over the eye-piece, and the exact collimation is obtained by the adjustment of the centering-screws of the substage, and by slight movements of the mirror or source of light.

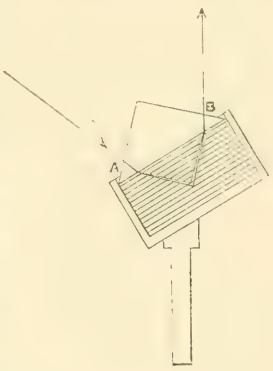
Amici Polarizing Apparatus.—We recently found in Florence a piece of apparatus belonging to an Amici Microscope, the construction of which was somewhat puzzling. On submitting it to Mr. H. G. Madan, he reports as follows:—

"The apparatus (fig. 137) consists of a square brass box containing 10 thin plates of glass (the glass has a decided blueish tinge, and is not very perfectly polished). On the top of the plates lies a right-angled prism of glass (refractive index = 1·512); the hypothenuse of the prism being parallel to, and in contact with, the top plate. The box is supported on a brass stem in such a position that the plane of the glass plates makes an angle of 118° (approximate) with the axis of the Microscope, under the stage of which it is fitted; and it

can be turned round on this stem in such a way as to preserve this angle constant for all azimuths.

When it is placed so as to reflect light from the sky or a lamp up the body of a Microscope, this reflected light is found to be plane-polarized in the usual manner effected by reflection from a bundle of glass plates. It seems clear that the instrument is intended for use as a polarizing mirror, and its action is of the following kind.

Fig. 137.



A beam of ordinary light incident on the prism at A emerges from the lower face, when it falls on the latter at angles less than the critical angle 41° 24′, deviated (and, of course, also dispersed) to such an extent as to fall on the bundle of glass plates at the polarizing angle, 56°. It is thus polarized by reflection in the usual way, and passes upwards into the prism near the edge B. In its passage through the prism its dispersion is entirely corrected, and it emerges as a colourless plane-polarized beam in such a direction as to illuminate an object on the stage and enter the object-glass of the Microscope.

The main advantage which the apparatus was intended to secure seems to be, to enable a ray to fall on the pile of plates at the polarizing angle without the necessity of placing the plates very obliquely to the axis of the Microscope. Thus there is a considerable gain in convenience and compactness."

Winkel's Micrometer Eye-piece.—In such micrometer eye-pieces as that of Gundlach (fig. 138), where the micrometer *m* is

Fig. 138.

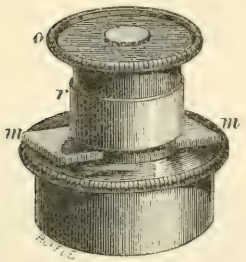
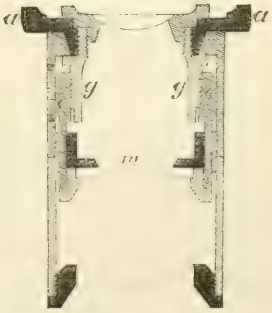


Fig. 139.



inserted in a slit (covered by a ring *r*) and the eye-lens *o* is focused on the micrometer by moving it in or out, the magnifying power is altered with each change in the position of the eye-lens.

Herr R. Winkel * has endeavoured to remove this objection by leaving the eye-lens in a fixed position and moving the micrometer vertically by the contrivance shown in fig. 139. Here the micrometer *m* is raised or lowered by turning the cap *a*, which is connected with a piece *g* having a thread cut in it, and by this means *e* with the micrometer is raised or lowered in a similar manner to the arrangement for correction-adjustment in objectives.

Herr R. Winkel overlooked the fact, however, that in getting rid of the objection to any movement of the eye-lens he had introduced a similar cause of error. Any movement of the micrometer shifts it from the plane of the image, and to bring the latter into coincidence again it is necessary to refocus the objective, and this alters the magnifying power.

Method of Webbing the Filar Micrometer.†—Mr. D. Gill gives the following directions for webbing a micrometer.

A spider (the variety is marked by a cross on the back, and is found in English gardens about decayed wood) is caught, and placed on a wire fork. The insect immediately attaches a web to the wire and begins to lower itself by the web to the ground. This web is wound up on the fork till ten or twelve turns, separated by a convenient space, have been secured. A brush with varnish is then passed along the prongs; the webs are thus securely fixed to the fork. The parallel prongs of the fork must be sufficiently far apart to allow the web-frame of the micrometer to pass between them. The frame to be webbed is placed on a flat dull black surface between the prongs of the fork, the latter being carefully arranged so that one of the webs lies nearly in the furrow ruled in the frame for its reception. As the web-frame is generally thicker than the fork, the web will now be stretched across the former, with a certain amount of tension, and is brought into the furrow with a finely pointed piece of soft wood. If the surface of the frame is well polished, and the furrows sharply cut without "burr," the web should leap sharply and decidedly into its place. Each end of the web is then secured by a drop of shellac varnish, which should be allowed to harden thoroughly before the frame is touched. The webs can be very readily so handled against a black background, with the aid of a hand lens of two or three inches focus. In experienced hands this method gives good results, but the following, which is generally followed on the Continent, is preferable.

A web about two inches longer than the width of the frame, is unwound from a cocoon,‡ and small pieces of lead are attached to its extremities by beeswax. One end of the web, with its attached lead, is laid on a piece of cork floating in a tumbler of water; the other

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 41–3 (2 figs.). Cf. Zeitschr. f Instrumentenk., v. (1885) p. 326.

† Encyclopædia Britannica, 9th ed., xvi. (1883) p. 248.

‡ It is asserted that webs from cocoons are more elastic, better shaped, and more durable than those obtained during an effort of the insect to escape. The best webs we have seen were from a cocoon obtained in Holland, but we have been unable to ascertain the name of the species of spider.

end is allowed to hang down in the water, where it becomes thoroughly saturated and untwisted. It is then laid across the fork, and dropped into its furrows in the manner above described, the little lead weights exerting a definite tension.

Varnish * is immediately applied to secure the webs, and the frame is not touched till it is dry.

The bevel-edge of the web-frame introduced by Repsold offers great facilities for accurate webbing, and should, Mr. Gill says, be employed in all future micrometers.

Schröder's Differential-screw Fine Adjustment.—This device by Dr. H. Schröder was exhibited by Messrs. Ross in the Inventions Exhibition of 1885, and is shown in figs. 140 and 141.

Fig. 140.

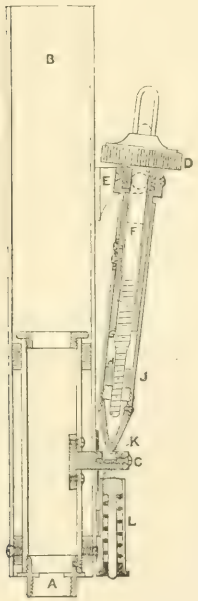
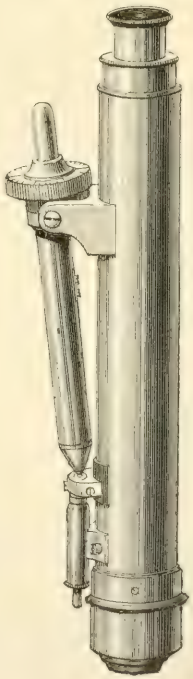


Fig. 141.



The nose-piece A is attached to a tube which is fitted to slide accurately in adjustable bearings in the body-tube B. The nose-piece tube has a short projecting arm C, by means of which it is pressed upwards by a strong spiral spring mounted in a cylindrical

* Argelander used to apply two drops of varnish at each end of his webs. He first fixed each extremity by a drop of shellac varnish, and after that had dried he applied a drop of copal varnish nearer the centre of the frame; the latter took a long time to harden, but gave ultimately a much stronger attachment.

box L outside the lower end of the body-tube. The arm C is moved against the spring by the differential-screw mechanism (with milled head D) which is gimballed on a bracket E attached to the upper part of the body-tube.

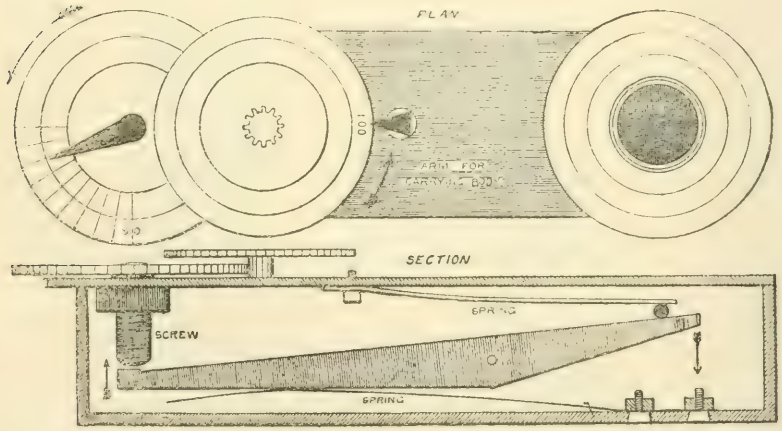
The differential-screw mechanism consists of a steel rod F (connected with the milled head D) which has two screw threads at the lower end, one working in a thread cut in the end of the inner tube G, and the other in the block H, which is soldered within the sheath J). When the milled head is turned to the left, the block, and with it the sheath, moves downwards while the rod itself, carrying the block and sheath, moves upwards. As the screws are cut respectively to 45 and 52 threads to the inch, the resultant motion is equivalent to the difference between the two screws, that is, to the motion of a screw of nearly 335 threads to the inch.

The end of the sheath is tipped with a small sphere K of polished steel, while the projecting arm of the nose-piece tube against which the end works has a corresponding concave bed of polished agate.

Delicate Fine Adjustment.*—A delicate system of fine adjustment is described anonymously, but said to be "after Dr. Royston-Pigott." It is shown in section and plan in fig. 142.

The primary wheel carries an axis of steel, 1–3 inch thick, having an external thread exactly 101⅓ turns per inch, which travels

Fig. 142.



in a brass nut having 60 turns of a corresponding thread. This wheel has 100 teeth on the rim and engages a pinion of 10 teeth which forms one piece with the secondary wheel (removable at will), also divided into 100 parts. Each of the divisions on the secondary wheel represents a movement of the focal plane through a space of 1/230,000 in. There is also provision for changing the fulcrum so

* Eng. Mech., xliii. (1886) p. 340 (2 figs.).

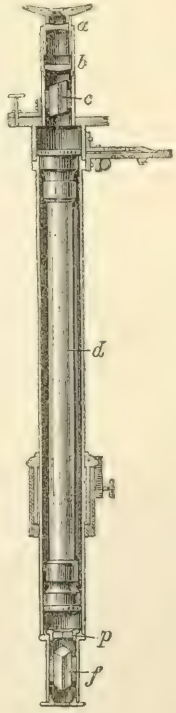
as to make the advantage of the leverage 4 instead of 2·3 times; the finest wheel divisions then read 1/400,000 in. focal motion.

The lever is very strong and rigid, and by a fork rests upon two studs diametrically placed on the sliding tube carrying the objective.

The sliding tube bears upon extremely thin edges so as to make contact with as small surfaces as possible and thus minimize the friction. It should be highly polished and trued with crocus and paraffin, and when finished well supplied with chronometer oil. A further advance would be to have the pivot holes of the lever jewelled, drilled, and polished into a conoid form. Great care should be taken to thoroughly "true" spherically the free end of the fine screw.

Several degrees of strength were tried of the depressing springs, acting as safety-guards on the objective touching "cover." That finally selected (on reversing the instrument so that the objective was vertical and the wrong way up) gave a resistance of 4 oz. Less than this strength would be sufficient were the Microscope used perpendicularly. "On the extreme accuracy of simultaneous contacts and pressures depends the steadiness of the image under high powers, which should never dance in focusing ever so lightly, as it nearly always does in most Microscopes."

FIG. 143.



Mechanical Stages.*—Mr. A. Y. Moore "condemns such mechanical stages as have the milled heads above the stage. They are all well enough for amateur work—looking at mounted slides—but the *room* is not there, and the usual form of stage is to be preferred, even though the projection of the milled heads may be such as to prevent the complete rotation of the stage (and this is a very nice point—to talk about)."

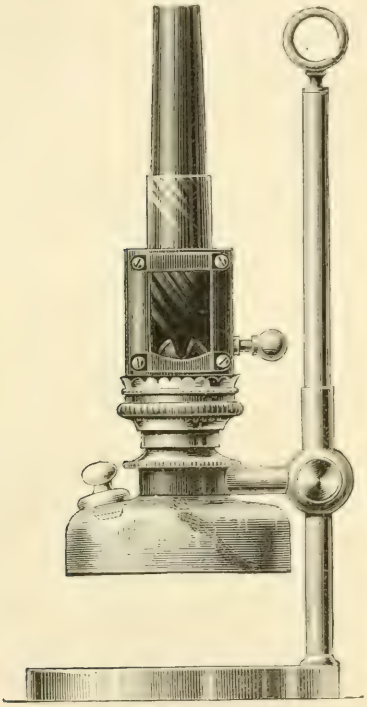
Ultzmann's Saccharometer.—Dr. R. Ultzmann has designed a cheap saccharometer to be used with any Microscope. The instrument (constructed by Reichert, of Vienna) is a Mitscherlich saccharometer of small size; it requires no special source of light, since when adapted to the Microscope it is sufficiently illuminated by the concave mirror.

In fig. 143 *a* is the eye-piece and *b* the objective of a small Galilean telescope, of which the focus is at *p*; *c* is the upper Nicol prism, to the mounting of which is fixed a vernier; *d* is the glass tube which holds the sugar solution, *p* is the plate of right- and left-handed quartz, and *f* is the lower Nicol. In using the instrument the body-tube is removed and replaced by the saccharometer; the mirror is then adjusted so as to send the light up the tube.

* The Microscope, vi. (1886) pp. 80–3.

The graduated circle of the upper Nicol is so divided that each division corresponds to the rotation produced by 1 per cent. of grape-sugar in the solution at a temperature of 20° Celsius; and by means of the vernier, readings are made to 0·1 per cent. In the case, therefore, of raw sugar, the percentage must be taken as three-quarters of the number of divisions indicated on the scale, that being the ratio of the rotatory powers of raw and grape sugar. In all respects the instrument is used exactly as any saccharometer of similar construction. The advantages claimed for it are that it is cheap, requires no special stand or artificial light, and gives the percentage of sugar in diabetic urine, &c., directly by the vernier readings.

FIG. 144.



Baker's New Microscope Lamp.—This lamp (fig. 144) is a simplified and economical form of the one recommended * by Mr. E. M. Nelson for high-power work. Its chief advantages are that the flame can be used much nearer the table than in the ordinary Microscope lamps, while the dark-chamber metal chimney is arranged to receive a 3 × 1 in. slip, which can be of white, blue, or ground glass. Brass plates with various sized slots for regulating the amount of light can also be inserted in front of the glass slip.

The metal chimney can be adapted to any ordinary paraffin lamp.

Examination of Graduated Circles with two and four Microscopes.†—When the errors of a divided circle are to be determined microscopically for small arcs round the whole circle, a very large number of observations is required. Dr. O. Schreiber investigates the general theory of the problem, and shows how it may be simplified in practice by a suitable selection and arrangement of the observations. The divided circle is fixed and is centered on a disc which is free to rotate; the Microscopes can be moved independently of one another about the centre of the disc, so as to traverse the whole circle. Given a certain number of divisions on the circle and a certain number of Microscopes, the theoretically perfect method would make

* See this Journal, iv. (1884) p. 125.

† Zeitschr. f. Instrumentenk., vi. (1886) pp. 1–5, 47–55, 93–104.

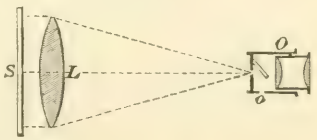
it necessary to fix the Microscopes successively in all possible positions with regard to one another, for each position to set all the divisions in succession under one Microscope and make readings in all the others. With four Microscopes and seventy-two arcs of 5° each, this would involve six million readings.

Dr. Schreiber's simplified method is as follows:—Fix the Microscopes at certain equal distances corresponding to certain arcs; bring one division into the first Microscope A, and measure micrometrically the distance of the division seen in each of the Microscopes from its zero point. These readings form a "set." A second set is got by turning the disc until the next division comes into A; observe all the arcs in this way, then all these sets form a "series." Thus a *series* consists of as many sets as there are arcs, and a *set* of as many readings as there are Microscopes.

It is impossible to abstract the details given by the author, for which reference must be made to the original paper. He finally gives "schemes" or arrangements of the observations for the following three cases; (1) Two Microscopes; (2) four Microscopes which can be fixed in any positions; (3) four Microscopes fixed in pairs opposite to one another; and compares the number of readings which they involve, from which it appears that method (2) is the most advantageous.

Measuring the Focal Length of a Lens.*—Prof. E. Lommel adopts the following method:—At the point in the tube of an eye-piece O (fig. 145) generally occupied by the cross-wires, a semi-circular screen is fixed which obscures half the tube, the screen being divided into two quarter-circles by a narrow vertical slit. Behind this is a mirror or prism which sends light from an opening *o* in the side of the tube through the slit and into the lens L, which is so placed that its axis coincides with that of the eye-piece; behind the lens is a plane mirror S which reflects the light back through it. The distance between lens and eye-piece is altered until the image of the slit appears sharply defined, and without parallax, as a prolongation of the slit itself. The distance between the lens and slit will then be the focal length, since the rays are in this case refracted through the lens as a parallel pencil, reflected back as parallel rays, and converge again to the principal focus at the position of the slit. This length is most conveniently measured by fixing the lens and the eye-piece upon stands which slide upon a graduated bar.

Fig. 145.

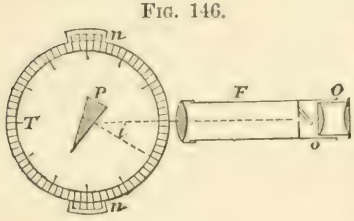


Measuring Indices of Refraction.†—Prof. Lommel also describes the following method:—The telescope F (fig. 146) of a spectrometer, fixed and focused to an infinite distance, is provided with the eye-piece O *o* described in the preceding note; the prism P whose

* Zeitschr. f. Instrumentenk., v. (1885) p. 124 (1 fig.).
† Ibid., p. 125 (1 fig.).

index is to be measured is adjusted in the usual way and fixed on the graduated disc T (with vernier at n and n), which is free to turn. The prism is first placed with one face perpendicular to the telescope, so that the image of the slit reflected from the face is seen in the centre of the field. This is the initial position. As the prism is turned a spectrum appears in the upper half of the field; each line of the spectrum, as it is made to coincide with the slit, represents a ray which has been refracted into the prism, reflected normally at the second face, and refracted out by the same path; hence the angle through which the prism has been turned is the angle of incidence i for that ray, while the angle of refraction is the angle of the prism. If the prism be turned further until the second face is perpendicular to the telescope, the difference of readings for the initial and final positions gives the latter angle, which is therefore the angle of refraction r for each ray. Then $\mu = \dfrac{\sin i}{\sin r}$.

Fig. 146.



The spectrum will reappear before the final position is reached at the point where the rays are refracted through the second, and reflected internally at the first surface; and the angle i is now the difference between the corresponding reading and that of the final position; this gives a second determination of the index. This method dispenses entirely with the usual collimator; it will be noticed, however, that the angle of the prism must be less than the critical angle of its substance.

This method is practically identical with that adopted by Prof. Abbe in his Refractometer, and Prof. Lommel subsequently acknowledged this,* not being aware of Prof. Abbe's paper.

Optical method for the absolute measurement of small lengths.†—M. M. de Lépinay makes use of Talbot's fringes, which are produced when a parallel-faced transparent plate is interposed in the path of a beam of light which has passed through a diffraction grating. If μ is the index of the plate, t its thickness, n the order of the fringe, then $2\dfrac{\mu - 1}{\lambda} t = n$.

The author measured by this means the thickness of a quartz plate cut parallel to the axis, and about 4 mm. thick, using the third spectrum produced by a grating of 400 lines to 1 mm. μ was taken as the mean of the best known measurements, λ as the mean of the wave-lengths found by Mascart, Ditschreiner, and Van der Willigen. Rays of different wave-lengths give a succession of values for t, of which the mean is taken. The author claims greater accuracy for

* Zeitschr. f. Instrumentenk., v. (1885) p. 200.
† Comptes Rendus, c. (1885) pp. 1377-9.

this method than can be attained by employing the fringes of Fizeau and Foucault. Conversely, having measured the thickness by other means, the author has applied the formula to determine the wave-length of the ray D_2, and finds a value identical with Angström.

It has been pointed out * that the author is not justified in concluding that the values found by Ditschreiner and Van der Willigen are incorrect, because it is not known to what degree of accuracy the thickness of the quartz plate had been measured.

Dotted appearance on Pleurosigma angulatum.†—Mr. J. B. Dancer once found that the oblique markings of a damaged valve had been removed by abrasion against the cover-glass; by no modification of the light could they be rendered visible. When, however, oblique illumination was directed in a line with the length of the valve, the transverse markings were distinctly visible and apparently uninjured. At first he thought that moisture had obtained access through the crack in the thin cover, and he dried the slide over the flame of a spirit-lamp carefully and repeatedly, but could not make the oblique lines visible, although they were distinctly visible on other broken valves contiguous to the special one under examination, and also on some portions of this valve; the oblique markings which had been dislodged were lying beside the edge of the damaged valve. Reasoning from what he had seen, he was led to imagine that the oblique markings were on the upper convex surface of the valve, and that the transverse markings were on the inside or concave surface. If we assume that the section of these raised markings are semi-cylindrical in form—that is, being rounded at the top—there would be an imperfect cylindrical lens formed wherever these pellucid ridges crossed the lower or transverse markings. These would present focal points of light and possibly images of objects, such as are seen in the eyes of beetles under certain conditions of illumination; if this be true, the so-called beads have no existence.

Mr. Dancer in a subsequent communication ‡ writes as follows:—"In my letter of the 28th May, I assume that the cross section of the ridges or markings on *P. angulatum* are semi-cylindrical, and also state that the *A. pellucida* ridges would form imperfect cylindrical lenses, where they cross the lower transverse markings. To render my meaning more intelligible, I may say that I had in my mind the lens introduced, I believe, by Chamblant, of Paris, about fifty years ago. If two pieces of polished glass, semi-cylindrical in section, have their flat surfaces placed one on the other with exactly their cylindrical surfaces at right angles to each other, a perfect lens is formed, having no spherical aberration. These lenses are much used in Paris, and occasionally in England, for hand reading-glasses and spectacle eyes. I have had such in use for both purposes for over forty years. Now, if we conceive that a number of minute lenses of this form were placed in juxtaposition, and examined under a Microscope, they would show images of any objects placed between the mirror and the

* Zeitschr. f. Instrumentenk., v. (1885) p. 325.
† Engl. Mech., xliii. (1886) p. 283. ‡ Ibid., p. 329.

source of the illumination; in fact, they would exhibit the same appearances as those presented by the eye of a beetle when viewed microscopically. From this we may assume that when the markings on diatoms are exactly at right angles, the most perfect lenticular performance would be visible.

A very pretty microscopic object may be produced in the following manner:—Place a metal ring on a slip of glass; in the centre of the metal ring put a minute quantity of the flowers of sulphur, and place a thin cover-glass over the metal ring; then hold the strip of glass at some distance above the flame of a spirit-lamp, in order to sublime the sulphur; when the slip of glass is placed under the Microscope, and viewed with a moderately low power, the sublimed sulphur will appear as minute plano-convex lenses, in which the image of an object placed between the mirror and the source of light will be beautifully shown. These plano lenses will remain transparent so long as the cover-glass is kept moderately warm. When cooling, the act of crystallization may be observed; when cold, these minute hemispheres are opaque. It may be necessary to repeat the experiment to insure the best results. If too much sulphur, or too much heat, the lenses are not microscopic. By blowing through a heated glass tube, on to the surface of the cover-glass, the act of crystallization can be retarded."

"Central v. Oblique Light."—Mr. E. M. Nelson thinks* that he has been hardly dealt with by the "Royal Microscopical Society," † who in place of meeting his "criticisms on their teaching" in a proper scientific spirit, have made a "personal attack" upon him and are threatening him with their sledge-hammer. This is the story of the wolf and the lamb in an intensified form.

How criticism should be met depends upon circumstances, and there are occasions when "personal attack" (adopting Mr. Nelson's term) is the only remedy, except silence, which is open to the aggrieved party.

Suppose Mr. Nelson had, for instance, published a statement expressive of his regret that Prof. Huxley was so determined an opponent of Darwinism, and that, in consequence, he intended to demonstrate the falsity of the Professor's teaching. Does he suppose that Professor Huxley would proceed to discuss the matter in a "proper scientific spirit," or that if in place of treating it with silent contempt (as he probably would) he made a "personal attack" by way of reply, would any one consider it as otherwise than well-deserved?

But Mr. Nelson has gone much further even than the case we have put. When he first misrepresented the "Royal Microscopical Society" as teaching the views which he combated, we pointed out that not only were those views not held as suggested, but that we had never met or heard of *any one* who holds or had ever held them. In decent society it is usual, when a person has disclaimed an opinion improperly attributed to him, to do one of two things—either to withdraw it (with or without an expression of regret at having made it,

* Engl. Mech., xliii. (1886) p. 300. † See note *supra*, p. 574.

according to the taste or temperament of the person guilty of the misrepresentation), or to substantiate it by a complete demonstration.

Mr. Nelson has attempted the latter alternative in a way which we will not characterize, but which can be properly appreciated from what follows.

Mr. Nelson's original statement, it will be remembered, was that the "Royal Microscopical Society" taught that "*nothing can be known about the structure of the diatomaceæ because all the diffraction spectra are not admitted*," a proposition which is so absurd on the face of it, that we find it impossible to believe that Mr. Nelson can have honestly supposed it to be held by any human being of only average intelligence, much less taught by the "Royal Microscopical Society."

The proof of his assertion Mr. Nelson gives as follows:—"Whether, for example, *P. angulatum* possesses two or three sets of striæ, whether striation exist at all, whether the visible delineation is caused by isolated prominences, or depressions, &c., no Microscope however perfect, no amplification however magnified, can inform us. Mon. Micr. Journ., xiv. 1875, p. 250."

Thus, although the pages of this Journal teem with passages which show that the views attributed to the Society are purely imaginary, Mr. Nelson passes over every one of them, even the authoritative paper of Prof. Abbe himself, and goes back more than ten years to cite a paragraph from the Monthly Microscopical Journal, which, as is well known, was an independent publication not under the control of the Society.

Is that a course of proceeding which entitles its author to demand that he should be dealt with in a purely scientific spirit?

Moreover, the paragraph quoted, as will be seen, in no way supports Mr. Nelson's original statement, or shows that any one, much less this Society, ever taught that unless all the diffraction spectra are admitted nothing can be known of the structure of the diatomaceæ. The Fellows of this Society hardly require to be reminded of what the diffraction theory really does teach, viz. first, that according to the coarseness or fineness of the structure, a greater or less number of the spectra are admitted, and secondly, that the greater the number admitted, the nearer will the image resemble the object. Were we far wrong in saying that a writer had mastered but little of the diffraction theory, who could sweep together the diatomaceæ in general—the coarse as well as the fine—as is done in Mr. Nelson's original statement, and who was further so oblivious of what has been said as to the indications of structure given by even a portion of a set of spectra as to write that this Society taught that "*nothing* can be known of the structure of the diatomaceæ, because "*all* the diffraction spectra are not admitted"?

As we said before, it was so much of a puzzle to us to comprehend why Mr. Nelson should go so far out of his way to try and fasten upon people views which existed only in his own imagination that we could only account for it by the supposition that he had been led away by the practice well known in other quarters to which we

referred, and had attributed to the Society the most absurd views for the purpose of glorifying himself by showing how he could dispose of them.

We fail to see the good of such tactics, for even if for the time the writer is able to pose as a victor, the victory in a few weeks is turned into worse than a defeat when the demonstration of the discreditable arts to which he has had to resort is published.

Mr. Nelson deprecates the sledge-hammer being applied to him. We shall be only too glad to put the sledge-hammer back in its place when he returns to the usages not only of scientific but of all decent persons, and abstains from the misrepresentations in which he has recently indulged.

Interpretation of the Six Spectra of Pleurosigma angulatum. This article by Mr. E. M. Nelson * is the most striking instance which we can recall, at any rate in microscopical matters, of a critic being "hoist by his own petard."

The article purports to show the error of the view of Dr. Eichhorn in his paper on this subject, referred to in this Journal, I. (1878) p. 186, and while to some extent excusing Dr. Eichhorn for his mistake, insists that the support given to him by "the R.M.S. is quite unpardonable."

Now, the simple fact is that Mr. Nelson has found a most egregious mare's-nest. The very thing that Mr. Nelson declares Dr. Eichhorn ought to have said, but did not say, he does say. The very thing that Mr. Nelson considers Dr. Eichhorn to be wrong in saying, he does not say.

Mr. Nelson has mixed up the *images* seen in the Microscope and the real structure of the *objects* which furnish those images, so that while Dr. Eichhorn who had "never seen a diatom" (as Mr. Nelson himself says) deals necessarily exclusively with images, and those false ones, he is denounced for his fallacies in dealing with true structures; and this Society, who for many years have published in every number of the Journal a table showing how many lines to the inch can be resolved with a given aperture, are supposed to believe than an aperture of 0·50 N.A. will resolve 100,000 per inch! †

All this arises from the fact that Mr. Nelson has never read the paper which he elaborately criticizes, either in the original German or translation. This is a strong assertion to make, and we should not venture to do so at second-hand, or if we had not extracted the admission from Mr. Nelson himself.

* Engl. Mech., xliii. (1886) pp. 337–8 (5 figs.) and 396.

† It would hardly be fair to deal seriatim with the various mistakes of Mr. Nelson's paper as they all flow from the one cardinal error of supposing that Dr. Eichhorn had predicted "true markings" in place of admittedly false images, but there is one matter of fact which should be corrected. Mr. Nelson declares that the points in question cannot be seen in the way described, but only by *enlarging* the diameter of the dioptric beam and cutting out the six spectra, "and until they are cut out nothing will be seen of the intercostal markings." The simple fact is that they were seen by Prof. Abbe, Mr. Stephenson, and other Fellows with a very *narrow* dioptric beam and without one of the six spectra being cut out.

The best, however, remains to be told. Mr. Nelson expresses his astonishment that it was not seen that "*insistance on the accuracy of Dr. Eichhorn's interpretation stultifies Prof. Abbe's magnificent diffraction theory.*" Now the problem solved by Dr. Eichhorn was set to him by Prof. Abbe himself; the solution was printed and published under his auspices; and it was sent by him to the Society as a remarkable confirmation of the diffraction theory! As the paper in this Journal from which Mr. Nelson quotes plainly states the part which Prof. Abbe's University took in the matter, the wonder is that no suspicion crossed Mr. Nelson's mind when he was writing as to the error into which he had fallen. It was hardly likely that any University would take the pains to make public the work of a student which "stultified the whole of the magnificent theory" of one of their most illustrious professors!

Mr. Nelson's mistake has its origin, we fear, in another attempt to throw a stone at the "Royal Microscopical Society." We are hardly called upon to repress a feeling of satisfaction that it should have resulted in so notable a miss.

Allison, F. B.—See Dancer, J. B.

American Society of Microscopists.—Ninth Annual Meeting.
[Circulars issued by the President, Secretary, and Director of Working Session.]
Amer. Mon. Micr. Journ., VII. (1886) pp. 114 and 119.
Micr. Bulletin (*Queen's*), III. (1886) p. 17.
The Microscope, VI. (1886) pp. 124–8.

Auckland (N.Z.) Microscopical Society, First Annual Meeting of.
Journ. of Micr., V. (1886) p. 196.

B., L. B.—**True cause of dotted appearance in** *P. formosum.*
Engl. Mech., XLIII. (1886) p. 300–1.

Bertrand, E.—**Nouvelles dispositions du Microscope permettant de mésurer l'écartement des axes optiques et les indices de réfraction.** (New arrangement of the Microscope allowing of the measurement of the separation of the optic axes and the indices of refraction.) [*Post.*]
Bull. Soc. Minéral. de France, VIII. (1885) p. 377.
„ „ **Sur la Mésure des indices de réfraction des éléments microscopiques des Roches.** (On the measurement of the indices of refraction of the microscopic elements of rocks.) [*Post.*] *Ibid.*, p. 426.

Bleekrode, L.—See Thompson, G.

Cutter, E.—**Cam Fine Adjustment?** [*Post.*]
The Microscope, VI. (1886) pp. 101–4 (1 fig.).

Dancer, J. B.—**What is the true cause of the dotted appearance on the P. angulatum.** [*Supra*, p. 691.]
Engl. Mech., XLIII. (1886) p. 283 and 329.
See also F. B. Allison, p. 351.

Dancer (J. B.), Proposed Annuity for.
[Statement of his services to science. "He invented microscopic photographs, which so much delighted and astonished us twenty-five or thirty years ago," and brought out excellent Microscopes moderate in price.]
Nature, XXXIV. (1886) p. 200.

Dieudonné, E.—**De l'Electro-mégaloscopie.** (On electro-megaloscopy.) [*Post.*]
La Lumière Électrique, XIX. (1886) pp. 64–7 (3 figs.).

Directory, Science.
[Microscopical and other Societies, *contd.*] *Sci.-Gossip*, 1886, p. 138.

Ewell, M. D.—**On Fine Measurements.**
[Criticism of Dr. Shanks' blood measurements, *supra*, p. 529.]
Amer. Mon. Micr. Journ., VII. (1886) pp. 119-20.

Exner, S.—**Ueber Cylinder, welche optische Bilder entwerfen.** (On cylinders which form optical images.) [*Post.*]
Arch. f. d. Gesammt. Physiol., XXXVIII. (1886) pp. 274–90 (10 figs.).
Exner's Repert. d. Physik, XXII. (1886) pp. 299–313 (10 figs.).

Francotte, P.—**Description du nouveau Microscope à dissection de Zeiss.** (Description of Zeiss's new dissecting Microscope.) [*Ante*, p. 507.]
Bull. Soc. Belg. Micr., XII. (1886) pp. 79–82 (1 fig.).

Giles, G. W. M.—**On Marine Collecting with the surface net.**
[Discs of vulcanite for use with lieberkühn, *supra*, p. 681.]
Sci.-Gossip, 1886, p. 121.

Gladstone, J. H.—See Thompson, G.

Gothard, E. v.—**Apparate für Aufnahmen himmlischer Objecte.** (Apparatus for photographs of celestial objects.)
[Describes the application of a Microscope to a telescopic camera for focusing.]
Zeitschr. f. Instrumentenk., VI. (1886) pp. 5–14 (10 figs.).

Harrington, M. W.—**The Microscope and the Telescope.**
[Reply to the question what is the difference between them.]
The Microscope, VI. (1886) pp. 106–7.

Hénocque.—**Appareils destinés à l'examen du sang.** (Apparatus for the examination of the blood.)
[The apparatus (resembling Donné's lactoscope and Hermann's hæmatoscope) allows of the examination of undiluted blood, which is placed between two plates of glass which have a triangular prismatic space between them varying from 0 to a third of a millimetre. The advantages claimed are that the blood does not require to be diluted, a minimum quantity only of blood is required to be used, and above all, it is not necessary to have recourse to the comparison of different tints. The plates can be applied to any spectroscope, and oxyhæmoglobin, hæmoglobin, and methæmoglobin can be successfully studied.]
Journ. Soc. Scientifiques, I. (1885) p. 24. (Soc. de Biologie 11th Jan.)

[Hitchcock, R.]—**Microscopical Exhibitions.**
["It is undoubtedly true that the efforts of any committee to please all the members of a society are fruitless, for there will always be some disaffected ones. It is impossible to know just what everybody wants, until somebody is assigned to a part that he does not want. Then, when too late to make any changes, the committee learns that such a person will not be present. This is one of the difficulties in arranging a systematic display of this kind. Some persons will not sacrifice personal interests to the wishes of a majority. They seem to think they should be permitted to show what will probably give them most notoriety, or attract most general attention to their work. Not being allowed to do that, they stay away entirely."]
Amer. Mon. Micr. Journ., VII. (1886) p. 117.

Höegh, E. v.—**Die achromatische Wirkung der Okulare von Ramsden.** (The achromatic action of the Ramsden eye-pieces.)
Central-Ztg. f. Optik u. Mech., VII. (1886) pp. 110–1.

Jennings, J. H.—[**Photo-micrography,** or] how to photograph Microscopic Objects; or lessons in Photo-micrography for beginners. And a chapter on preparing Bacteria, by R. L. Maddox.
viii. and 128 pp. and 30 figs. (8vo, London, 1886). (Reprinted from the 'Photographic News,' with many additions.)

Mayer, A. M.—**On the Well-Spherometer;** an instrument that measures the radius of curvature of a lens of any linear aperture.
Amer. Journ. of Sci., XXXII. (1886) pp. 61–9 (7 figs.).

Miles, J. L. W.—**President's Address** [to the Manchester Microscopical Society].
[Deals mainly with illumination.]
Ann. Report for 1885 (1886) pp. 15–25.

NELSON, E. M.—Central *v.* **Oblique Light.** [*Supra*, p. 692.]
Engl. Mech., XLIII. (1886) p. 300.

" " **The resolution of Diatoms whose striæ are of unequal fineness.** [*Post.*]
Ibid., p. 328 (1 fig.), p. 396.

" " **The interpretation of the Six Spectra of Pleurosigma angulatum.** [*Supra*, p. 694.]
Ibid., pp. 337–8 (5 figs.), p. 396.

Objectives, New.

["The new 1/8 in. objectives of Zeiss, made of the new glass, will be in the market very soon—indeed, they are expecting daily to receive a supply. Hereafter Mr. Zeiss will not make any more of the celebrated 1/18 in. objectives, but will provide another lens to take its place."]
Amer. Mon. Micr. Journ., VII. (1886) p. 118.

PELLETAN, J.—**La Théorie du Microscope et l'Optique simplifiée.** (The theory of the Microscope and simplified optics.)

[Characteristic introduction to a series of articles intended to be published on simplified optics.]
Journ. de Microgr., X. (1886) pp. 279–85.

Piersol's (G. A.) Photograph of Bacillus tuberculosis.

[× 1000—"shown as clear and distinct as when viewed with the Microscope."]
Amer. Mon. Micr. Journ., VII. (1886) pp. 99.

Queen's (J. W. & Co.) Acme No. 4. Microscope. [*Post.*]
Micr. Bull. (*Queen's*), III. (1886) p. 17 (1 pl. and 1 fig.).

Resolving 152,000 lines to the inch.

[Correspondent thinks that "*with a little patience* it could be accomplished, for I have already resolved 140,000 with the same objective and illumination!"]
Micr. Bull. (*Queen's*) III. (1886) p. 14.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XI., XII.**

[Diatomic beading and images. Diatomic colours.]
Engl. Mech., XLIII. (1886) pp. 313–4 (7 figs.), pp. 383–4 (2 figs.).

[ROYSTON-PIGOTT, G. W.]—**Delicate Fine Focussing Adjustment.** [*Supra*, p. 686.]
Engl. Mech., XLIII. (1886) p. 340 (2 figs.).

S., H. G. F.—**A Concentric Microscope.**

[Modifications in Cox's Microscope with concentric movements * would give it the essential features of the best known English and American Microscopes. (1) The tail-piece (preferably one only) should have a clamp above the stage to fix it parallel to the optic axis; (2) the mirror-bar should be removable, and arranged to clamp on one of the feet of the base; (3) the stage should have mechanical movements like "Watson's or Ross's best diatom stage"; and (4) a "combination condenser" like Swift's or Pillischer's should be applied. "The concentric or radial construction . . . gives such extreme stability at every angle of inclination that . . . it seems destined to supersede the 'Jackson' model, as that superseded the 'Ross' with the majority of makers."]
Engl. Mech., XLIII. (1886) p. 352 (2 figs.), p. 375.

THIESEN, M.—**Ueber die Ablesung von Normalbarometern und überhaupt von grösseren Flüssigkeitsoberflächen.** (On the reading of normal barometers and large fluid surfaces.)

[The difficulty of exact readings where the surface of the mercury is large has led to various contrivances based on the principle that the distance between an object and its image seen in a plane reflecting surface is bisected by the surface. Marek substituted for Pernet's fixed index the image of a horizontal thread thrown by a lens into the centre of the tube; but the results obtained are not satisfactory. Dr. Thiesen uses the scale at the back of the tube as the object; the reading for the surface of the mercury is then found by a simple micrometric measurement of the dis-

* Cf. this Journal, iv. (1884) pp. 279–81.

tance between a division on the scale and its reflected image. If, e.g., the distance between 771 mm. and its image measured in fractions of one of the visible intervals is 1·4 mm., then the true reading is 771·7 mm. A great advantage of the method is that it obviates all cathetometer adjustments and errors. The errors introduced by refraction through parts of the glass tube, while not entirely eliminated, are less pronounced than in other methods.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 89–93 (4 figs.).

THOMPSON, G.—**The determination of the Index of Refraction of a fluid by means of the Microscope.** *Nature*, XXXIV. (1886) pp. 157 and 217. Also criticisms by J. H. Gladstone and L. Bleekrode, pp. 192 and 290.

THOMPSON, S. P.—**Notes on some new Polarizing Prisms.**

[1. Ahrens', *ante*, p. 397. 2. Simple modification of the Nicol prism, giving wider angle of field. *Post.*]

Phil. Mag., 1886, pp. 476–80 (1 pl.).

TOISON, J.—**Éclairage intensif en micrographie.** (Condensed illumination in microscopy.)

[Suggests as a substitute for the Abbe condenser an objective—1/7 in. 0·94 N.A.—fixed in the cylinder diaphragm-holder.]

Journ. Sci. Méd. Lille, 1885, 5 pp.

WALLACE, E., Jun.—**The Amateur Photographer: A Manual of Photographic Manipulation, intended especially for Beginners and Amateurs.** 205 pp., 1 phot., and figs. (8vo, Philadelphia).

WATERHOUSE, A.—**Blood Measurements.**

[Table of measurements of blood-corpuscles of various species of Mammals].

The Microscope, VI. (1886) pp. 97–101.

WEYERS, J. L.—**Le Microscope Entomologique.** (The Entomological Microscope.) *CR. Soc. Entomol. Belg.*, 1886, No. 71, pp. xc.–xciii.

β. Collecting, Mounting and Examining Objects, &c.*

Histophysics of the Red Blood-corpuscles.†—Drs. S. J. Meltzer and W. H. Welch have had occasion in the course of their investigation on the colouring matter of the blood, to search for the remains of the uncoloured red blood-cells, the so-called phantoms. Their experience was that these can be rendered more evident by means of certain substances capable of coagulating albumen, such as prussic acid (saturated solution), pyrogallic acid (20 per cent.), copper sulphate (10 per cent.), chlorate of potash (6 per cent.), silver nitrate (3 per cent.). The phantom corpuscles appear as dark rings; on the application of chlorate of potash as pale bluish discs. The last three reagents have the advantage of not altering blood-corpuscles present with the phantoms.

Counting Blood-corpuscles.‡—For counting white blood-corpuscles M. J. Toison adopted the staining method, using the basic anilins, of which he found methyl-violet 5 B the most reliable.

The formula given is:—Distilled water, 160 c.cm.; glycerin at

* This subdivision contains (1) Collecting Objects; (2) Preparing, (*a*) in general, (*b*) special objects; (3) Separate processes prior to making sections; (4) Cutting, including Imbedding and Microtomes; (5) Staining and Injecting; (6) Mounting, including preservative fluids, cells, slides, and cabinets; (7) Examining objects, including Testing; (8) Miscellaneous matters.

† Centralbl. f. d. Med. Wiss., 1884, p. 721.

‡ Journ. Sci. Med. de Lille, 1885, 4 pp.

30°, 30 c.cm.; soda sulphate, 8 grms.; soda chloride, 1 grm.; methyl-violet 5 B, 0·025 grm. The violet was dissolved in the glycerin, diluted with half the distilled water, the salts in the other half; the two mixed and filtered when cool. The staining fluid was mixed with the blood and then placed in a cell or moist chamber. The staining action is well marked in 5 to 10 minutes, and attains its maximum in 20 to 30 minutes. The white blood-corpuscles appear as small granular violet balls, which are easily distinguished from the greenish coloured red corpuscles.

Obtaining Hæmoglobin Crystals.*—Dr. St. v. Stein places a thin layer of fresh defibrinated blood upon a slide, and when it begins to dry at the edges, covers it over with Canada balsam, which should not be too fluid as the crystals are then less permanent. As long as the balsamic odour is perceptible, the specimens remain without a cover-glass. The balsam layer is then removed by means of a knife moistened with ether, turpentine, or oil of cloves. A cover-glass is put on and sealed up with balsam or asphalte. Such preparations have kept well for ten years.

Preparing Muscle to show Nerve Extension.†—The procedure used by Dr. R. Mays for making preparations to show nerve extension in muscle is a combination of the osmic acid method with gold staining. The addition of the gold salt is to prevent the browning and clouding of the muscle substance, which occurs after osmic acid only, associated with the previous swelling of the muscle in dilute hydrochloric acid. Dr. Mays' procedure with thin muscle from which he obtained suitable preparations is as follows:—

The fresh muscle is placed in a mixture of 0·5 per cent. gold chloride solution (1 part), 2 per cent. hyperosmic acid (1 part), and water 50 parts. It is then cleared up in a mixture of glycerin 40 parts, water 20 parts, and 25 per cent. hydrochloric acid, 1 part. This procedure does not, however, prevent clouding and browning in thick muscles. To avoid these inconveniences altogether, Dr. Mays recommends the following method. The fresh muscle is laid for 12 hours in a 2 per cent. solution of acetic acid, then for 2 to 3 hours in the gold-osmium solution (0·5 per cent. gold chloride solution 1, 2 per cent. osmic acid 1, 2 per cent. acetic acid 50). For clearing up the above, glycerin mixture is used.

Although the foregoing methods give excellent results, they fail to distinguish between the intra- and hypolemmal parts of muscle; but in an appendix Dr. Mays adds a method by which this differentiation becomes possible and which shows that by the gold-osmic-acid treatment the nerve-fibres are stained to their ends, i. e. up to their entrance into the muscle. The muscle is thoroughly soaked in a 0·5 per cent. solution of arsenious acid, and then for 20 minutes in a freshly made mixture of 1 per cent. gold chloride, 4 parts; 2 per

* Centralbl. Med. Wiss., 1884, p. 404.

† Zeitschr. f. Biol., xx. p. 449. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 401–2.

cent. osmic acid, 1 part; 5 per cent. arsenic acid, 20 parts. The muscle having been washed, is exposed for three hours to the sunlight at a temperature of 45° in a bath of 1 per cent. arsenic acid solution. The glycerin and hydrochloric acid mixture is used for clearing up. In successful preparations the nerve with its hypolemmal parts is stained throughout.

Demonstrating Nerve-endings in Striated Muscular Fibre of Man.*—For this purpose Prof. M. Flesch proceeds as follows:—

The muscles are placed as soon as possible *post mortem* in a 0·5 per cent. gold chloride solution until they appear of a straw yellow colour; they are then exposed to the light in dilute acetic or formic acid. After reduction has taken place, the muscle is ready for examination. Hardening is done in alcohol and imbedding in tallow and paraffin without previous saturation with turpentine or chloroform.

The author calls attention to the fact that in one and the same specimen, differences of staining are discernible after treatment with gold chloride; these in some measure depend upon the unequal saturation of the muscle with the gold solution, but in greater part are to be referred to structural differences of the muscular fibres. Differences of staining in reference to intensity and quality are distinguished, the former depending on the histological non-equivalence of individual fibres; the latter consisting in the staining showing every transition stage from rose through purple-red, and violet to pure blue.

Demonstrating an Endothelial Element of the Primitive Nerve Sheath.†—To show the intercellular substances in the vicinity of the nuclei of Schwann's sheath, Dr. A. Gruenhagen teases out the nervus ischiadicus of the frog; then pours over the preparation for two or three minutes some drops of a 1/2 per cent. solution of silver nitrate. He then washes with H^2O, dehydrates in absolute alcohol, stains with concentrated hæmatoxylin, dehydrates again, and mounts in balsam.

Preparing Batrachian Larvæ and Regulating the Circulation.‡—Dr. S. Mayer describes two methods of much technical interest.

The first is a process by which living larvæ can be fixed for microscopic research in a very short time, and this without damage, as is the case with curara injection. It consists first in passing a moderately strong current through the brain and cord, and then placing the larvæ in a solution of curara. By the electrization the animals are fixed in half a minute and the fixation is rendered permanent in the curara solution, the electric palsy being at once succeeded by the curara palsy. By this means the larvæ can be brought in a few minutes to a condition suitable for microscopical

* MT. Naturforsch. Gesell. Bern, 1885, pp. 3–25 (1 pl.).

† Arch. f. Mikr. Anat., xxiii. (1884) pp. 380–1 (1 fig.).

‡ SB. K. Akad. Wiss. Wien, xci. (1885) pp. 204–38 (3 pls.). Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 390–1.

examination, while the curara method by itself requires at least a quarter of an hour.

The second procedure is a very simple method for influencing the rapidity of the blood current in the larval tail. It depends on Dr. Mayer's observations that by the imposition of the cover-glass the blood current ceases in the covered parts of the larva, even though the cover-glass be supported at the edges by glass splinters, but that it is again restored as soon as a drop of water is run under the cover-glass. Dr. Mayer traces back these appearances to the pressure which exists in consequence of the capillary adhesion between the cover-glass and the highest point of the object. The addition of water whereby the cover-glass is removed from the object, now brings it to pass that the capillary-adhesion pressure is either diminished or altogether removed according to the size of the drop added. Accordingly in the size of the drop of water exists a means of keeping the blood current at its normal rapidity, or of diminishing it in any desired degree to complete arrest.

Preparing the Radula of Cephalophorous Mollusca.*—Dr. R. Rössler places the living animals for half an hour in a moderately hot concentrated sublimate solution; then having got ready the pharynx, he treats it for another half hour with sublimate, washing thoroughly with water and staining with picro- or borax carmine, or with hæmatoxylin.

According to the author, paraffin penetrates between the toothlets of the radula with great difficulty, and most sections are consequently torn in cutting. The best results were obtained by transferring the object from absolute alcohol to yellow benzol, slowly adding warmed paraffin, and finally transferring to pure paraffin. The paraffin is afterwards dissolved out in benzol. Turpentine oil should be avoided, as it makes the radula brittle.

Thin Sections of Entomostraca, &c.†—Dr. G. W. M. Giles describes a method of obtaining thin sections of Entomostraca and other minute crustaceans, which he believes is somewhat novel. On account of their small size and the hardness of their chitinous coats, they do not lend themselves well to the paraffin method, as the knife is apt either to ride over them or to compress them, and drive out the paraffin filling up their interstices. Moreover, on account of the bulk of the apparatus and the difficulty of maintaining a constant temperature by means of spirit-lamps, it is extremely difficult in practice to carry it out on shipboard. The method described is, however, a somewhat rough and uncertain one, and it is only occasionally that results at all comparable to those of the paraffin method are obtained. It is, moreover, applicable only to very minute organisms.

The course of procedure is as follows:—The animal is taken from absolute alcohol and immersed in oil of cloves, where it is left until it is completely clarified. It is then placed in a watch-glass

* Zeitschr. f. Wiss. Zool., xli. (1885) pp. 447–82 (2 pls. and 1 fig.). See this Journal, v. (1885) p. 434.

† Sci.-Gossip., 1886, p. 122.

containing a few drops of Canada balsam (undiluted), and placed over a spirit-lamp at such a height as to melt without danger of burning the balsam. In about a quarter of an hour the balsam has driven out the clarifying agent, and penetrated throughout the entire structure of the animal. A single drop of balsam is now placed on a glass slip, and heated until it cools hard. Now take up the animal, together with a bead of balsam, on the point of a needle, and place it on the balsam on the slide, previously warmed, and prop it up in such a position that the plane of the sections desired may be parallel to that of the slide, holding it thus until the balsam has cooled sufficiently to keep it so.

There is just one consistency of balsam at which it may be readily sliced with a razor, without sticking to the blade, and yet is not brittle; and it is this condition which it is desired to obtain for the bead on the slide. Accordingly, when quite cold, it should be tested with the edge of a scalpel. If too soft, the slide must be warmed over a lamp for a while; if too hard, it must be removed from the slide and replaced in the watch-glass, to which a drop of fresh balsam has been added. In the difficulty of obtaining exactly the right consistence lies the uncertainty of the method; but when this is hit upon successfully, really beautiful sections can be most easily obtained by slicing down the bead with a sharp razor or lancet, as in the ordinary hand method. The sections may be allowed to fall from the razor on to the slide until all the material is exhausted, and then covered with dilute balsam under a large cover-glass, or they may be picked up one by one on the point of a needle, and arranged in order on a separate slide, which has been varnished with a thin coat of balsam so as to retain them in their respective places while mounting. The method is also useful for obtaining sections of coralline Algæ, whose structure, when deprived of their lime, is so rotten that it is extremely difficult to mount even the smallest sections whole, unless supported by some exceptionally firm imbedding material.

Preparing Echinodermata.*—Dr. O. Hamann obtained good fixation without undue contraction by injecting the somatic cavity of Asteridea with a 1 per cent. chromic acid solution. When injected the animals are to be placed in a vessel containing a similar fluid. Good results were also obtained from a 1 per cent. chromic acid solution to which a few drops of a 1 per cent. osmic acid solution had been added, and also from Kleinenberg's picro-sulphuric acid. These acids are also advantageous, because they slowly decalcify the star-fishes and therefore render them more amenable to the sublimate solution. By the use of boiling water the ambulacral feet may be obtained in their extended position, while preservative media penetrate only slowly and irregularly within the substance of the body.

For staining, the author used Ranvier's picro-carmine, also a neutral (acetic acid) carmine, Böhmer's hæmatoxylin, and also

* 'Beiträge zur Histologie der Echinodermen, Heft 2, Die Asteriden,' 126 pp., 7 pls. and 3 figs., 8vo, Jena, 1885.

Ehrlich's hæmatoxylin to which eosin had been added in the following proportion:—100 cc. Ehrlich's logwood solution, 15 cc. of 1 per cent. watery solution of eosin. For staining maceration specimens, a methyl-green solution with acetic acid proved useful.

Preserving Cilioflagellata.*—Prof. O. Bütschli preserves Cilioflagellata in picrosulphuric acid, afterwards changing to alcohol. By this means the flagella are extremely well retained. The posterior flagellum was well observed after the action of osmic acid vapour; but a 1 per cent. solution caused it to disappear.

Mounting Foraminifera in Balsam.†—Mr. J. Carpenter gets rid of the air in Foraminifera by boiling them in dilute potash for a few moments, afterwards in pure water, and thoroughly drying them. Then put them into a test-tube with spirit of turpentine, and boil for a few minutes over a spirit-lamp. When wanted for mounting, place a drop of balsam on a slip, take up a small quantity of the shells on the point of a pen-knife or a homœopathic spoon, and immediately place in the balsam; then put on the cover-glass, but do not use any pressure. They require baking in a slow oven for some time to thoroughly harden the balsam.

Water-washed Diatoms.‡—Dr. G. H. Taylor recommends the following method of preparing samples. A quantity of the mud containing the diatoms is placed in a large jar with two or three times its bulk of clean water, and thoroughly shaken up. After settling for ten minutes, about half the water is poured off into another jar, and the first is refilled, shaken, allowed to settle as before, and most of the water poured off. This is kept up until the water is perfectly clear at the end of ten minutes. The light portions poured off are saved for future treatment. The heavy material which contains all but the smallest diatoms has much sand mixed with it. To get rid of this it is shaken up in the jar of water, and the top part almost immediately poured off. This is repeated several times, refilling the jar with pure water each time until the heavy sand remaining shows but few diatoms mixed with it. The material obtained by the last pourings, consisting of nearly all the diatoms, and the *fine* sand, is now boiled in water with the addition of a little cooking soda, and is then placed in a large bottle filled with pure water, shaken up, and poured off after standing five minutes. The bottle is refilled, and the process continued for several hours, the time of settling being gradually reduced to three or even two minutes. The remaining material is then placed in a shallow dish, a little at a time, with a small quantity of water, and gently rocked and rotated, causing the diatoms and lighter particles to rise in the water, when they can either be poured off or dipped out with a pipette, leaving most of the sand behind.

* Morphol. Jahrb., x. (1885) pp. 529–77 (3 pls. and 4 figs.). See this Journal, *ante*, p. 460.

† Journ. of Micr., v. (1886) p. 50.

‡ Proc. Amer. Soc. Micr., Eighth Ann. Meeting, 1885, pp. 207–8.

Cleaning Diatoms from Marine Mud.*—Dr. G. H. Taylor places a quantity of the mud containing diatoms in a large jar, which is then filled with clean water, thoroughly shaken, and allowed to settle for ten minutes. One-half is then poured off into another jar, the first refilled, shaken up, and again allowed to settle for ten minutes, when the top portion is poured off into a third jar. This process is continued with the first jar until the water is clear after settling for ten minutes. The material is then taken from the first jar in small quantities, and "sanded" by placing each portion in a shallow dish with a moderate quantity of water, and rotating the dish so as to cause a vortex in the water, when the diatoms and lighter matter will rise in the water, and can be poured off into a bottle, leaving the sand and heavier particles behind. This process is repeated with each portion until only sand is left in the dish. The "sanded" material is now placed in an evaporating dish and dried. When dry, nitric acid is poured upon it, and it is boiled until fumes cease to appear, when a few grains of bichromate of potash are dropped in, and, after boiling for a few minutes more, allowed to cool. When cool, the acid is poured off, the dish refilled with sulphuric acid, boiled, and a little bichromate of potash added. When the sulphuric acid has thoroughly cooled, it is poured off, *but not into water*, and the material in the dish washed two or three times with clean water, stirring it up well on each supply, and allowing it to settle each time before decanting.

It is now again "sanded" by rotating the dish and pouring off the top portion of the fluid into the bottle, adding more water each time, until only sand is left in the dish. The material in the bottle, now rich in diatoms, is shaken up, allowed to settle, and the water poured off, until every trace of acid is removed, when the material is returned to the clean evaporating dish, which is nearly filled with water and boiled. A very small piece of caustic potash is now added, and the boiling continued for two or three minutes, when the contents are poured into the bottle. The material is now again washed by shaking, settling for five minutes, and pouring off most of the water, repeating the operation with fresh quantities of clean water and decreasing the period of settling to two or three minutes, until the water is free from any trace of alkali. The material is now again "sanded" in small quantities at a time, and the lighter portion drawn off by means of a dropping tube. The material thus withdrawn contains almost all the diatoms. When all the material has been treated in this way, it is extremely rich, containing but little sand and a small amount of vegetable silica, but may be still further improved by more time and labour. The material is washed several times in distilled or filtered rain-water, and about five to seven minutes allowed for settling. About twenty drops of ammonia are now added, the fluid well shaken, and the washing continued as before. One or two more "sandings" with distilled water will now give pure diatoms free from foreign matter or sand. Care should be taken not to overlook the large forms of diatoms which frequently adhere to the glass.

* Proc. Amer. Soc. Micr., Eighth Ann. Meeting, 1885, pp. 208-10.

Engelmann's Bacterium-Method.* — Dr. T. W. Engelmann replies to various objections to his bacterium-method for detecting the evolution of oxygen,† especially those of Pringsheim,‡ and points out the limits to the use of the method, which cannot be applied to the quantitative determination of the oxygen evolved. He further describes the conditions most favourable for the employment of the process.

The drop must contain only a single kind of bacterium, and must therefore be taken from a pure culture. The best results are obtained with a bacterium of high oxygen-requirement. The bacteria should be neither too large nor too small; cocci of 1–2 μ diam., or rods 2–3 μ in length and about 1 μ in diam. afford the best results. The number of individuals of the bacterium must be large enough for them to collect rapidly round the source of oxygen; the drop should appear slightly turbid to the naked eye. During observation, evaporation must be carefully prevented from the margin of the cover-glass.

Solid Nutritive Media for Bacteria.§—M. E. de Freudenreich compares Dr. Hesse's apparatus, for testing for Bacteria in the atmosphere, with that of Dr. Miquel, of Montsouris. In the former case, air is drawn through a tube lined with gelatin; in the latter method the air is passed through water and then distributed in drops to a series of tubes containing sterilized broth. The advantage in this latter method lies in the fact that, when any alteration is observed in the broth in any one tube, this tube can be examined; whereas in Hesse's method, in order to examine a single colony the whole apparatus has to be exposed to the atmosphere, and disturbing conditions may occur; and although as a rule Bacilli develope on the spot on which they fall, yet not unfrequently, and especially during summer, they may spread so rapidly that the whole of the gelatin becomes liquid.

The author undertook numerous comparative experiments with the two methods. Out of a series of seven experiments, undertaken at the same time and place, and using peptonized gelatin in the one apparatus and peptonized beef broth in the other, he obtained the following results: Four were more favourable to the liquid medium (that is more bacteria were found by this method than by the gelatin method, in the same volume of air); one was favourable to the solid medium; two gave identical results with the two media. The author, therefore, concludes in favour on the whole of Dr. Miquel's method; but adds that Dr. Hesse's is not to be neglected, on account of the ease of transport and manipulation of his apparatus.

Cultivation of Comma-bacilli.‖—Dr. F. Hueppe has obtained very interesting results as to the spores of the cholera bacillus by slide-cultures, which during the observations were kept at a temperature of 34°–37° C. on a hot stage. The slides used were hollow ground, so as to

* Bot. Ztg., xliv. (1886) pp. 43–52, 64–9.
† See this Journal, i. (1881) p. 962. ‡ Ibid.
§ Arch. Sci. Phys. et Nat., xv. (1886) pp. 105–20.
‖ Fortschr. d. Med., iii. (1885) p. 619.

allow a sterilized cover-glass to fit over them. The nutrient media were thin layers of gelatin or agar. By this means the lively movements of the bacilli were limited as to their locality, and thus became accessible to continuous observation. Of course sufficient provision was made for the presence of air and moisture. Geissler's parallel-walled chamber upon which very thin layers of gelatin and agar can be spread, proved of much service. For the hot stage the Löwit-Reichert modification of Stricker's stage, for which there is a special condenser, was used.

Special Criterion of Tubercle-bacilli.* — Dr. Voltolini states that if cover preparations of phthisical sputum be laid in strong nitric acid (1·45–1·50 sp. gr.) before staining with the Ehrlich solution, the bacilli are afterwards found to have a granular moniliform appearance. The author considers this a special characteristic of tubercle-bacilli, as he has not found it in any other micro-organism, not even in the Lepra-bacillus.

Application of "Ranvier's" Alcohol.†—Dr. J. H. List recommends one-third (Ranvier) alcohol, in conjunction with 10 per cent. salt solution as the best isolation medium for pavement epithelia, one of its principal merits being that cells thus isolated stain extremely well. Ranvier's alcohol is, however, less suitable for goblet cells which are much better studied after being treated with Müller's fluid or osmic acid.

Schällibaum's Collodion.‡—Mr. A. B. Lee finding it stated § that it is necessary when using Schällibaum's fixation method to heat the slide until the oil of cloves is driven off, writes to say that this is an error, and that it is not necessary to heat the fixative to such an extent, but merely until the clove oil runs easily. For this purpose a water bath may or may not be used; it is quite sufficient to hold the slide for a few seconds over a spirit-lamp or Bunsen's burner, moving it to and fro the while. The procedure is as safe as it is convenient.

Imbedding with Benzol and Cutting very delicate Objects.‖—Dr. A. Brass after alluding to the inconveniences attending the employment of chloroform for imbedding histological preparations, strongly advocates the use of benzol for this purpose.

The stained and hardened objects are first of all immersed in concentrated alcohol, which is dehydrated by the addition of dried copper sulphate. All the water having been removed from the section the alcohol is passed off and the preparations covered over with pure benzol. The stoppered glass vessel in which the previous steps are effected, is then transferred to a water bath at a temperature of 30°, and as much finely scraped paraffin added as will dissolve. After being kept at this temperature for half an hour, the preparation is transferred to pure paraffin which is just at its melting point. To every 100 parts of paraffin about four to six parts of white wax are added. Preparations the size of a pea are left in the paraffin for

* Breslauer Aerztl. Zeitschr., 1885, No. 15.
† Zeitschr. f. Wiss. Mikr., ii. (1885) p. 514.
‡ Ibid., p. 522. § Ibid., p. 571. ‖ Ibid., pp. 300–5.

half an hour; for larger objects a correspondingly longer time is required. The preparations thus soaked in paraffin are next allowed to set on a glass plate. The sections are fixed in the usual manner by the shellac solution, and this having been done the paraffin is dissolved out in benzol. When it is certain that all the paraffin has disappeared, Canada balsam dissolved in benzol may at once be dropped on and the cover-glass put in place.

When dealing with delicate sections or with fragile and easily lacerable tissues, all disposition to tear or break up may be avoided by brushing over the upper surface of every section, as soon as it is cut, a thin layer of collodion. By this means the preparation is covered and held together by an adhesive and continuous coat. The collodionized surface is that which is applied to the slide. The other steps of the process are, of course, the same as before.

It may be noticed that all the author's specimens were treated with a 5 per cent. solution of sublimate heated to 60°–70°; pieces the size of a pea are to be left in for 10 minutes; those the size of a walnut for half an hour. Thus hardened, the specimens are transferred directly to 70 to 80 per cent. alcohol for at least 12 hours, and afterwards to 90 per cent. alcohol until all traces of the sublimate have disappeared. The complete extraction of the sublimate may be known by evaporating a drop or two of the last spirit in a watch-glass, in order to ascertain if any acicular crystals of sublimate be deposited.

The author recommends carmine for staining purposes, and the fluid he employs is made as follows:—To a large teaspoonful of carmine are added 500 grammes 70 per cent. alcohol, and to every 100 grammes of the foregoing 15 grammes pure hydrochloric acid. The mixture is then boiled for some time in a water bath. After boiling there should be a residue of carmine; if not, add more carmine and boil again. The spirit lost by evaporation is to be replaced by 96 per cent. alcohol. The fluid, having been filtered, is ready for use. Preparations may be stained in bulk, and overstaining removed by the use of 70 per cent. alcohol.

By the foregoing method the complicated karyokinetic figures and every intracellular detail can be demonstrated in the clearest manner.

Sections of Teeth.*—Dr. W. C. Brittan finds that very beautiful sections of the jaws of small animals with the teeth *in situ* may be made in the following way:—

The jaws of a well injected animal are placed for a few days in 50 per cent. alcohol, then into absolute alcohol for about two weeks, then with a fine sharp file cut away the bone from both sides of the jaw where the section is desired until, by holding to the light, the pulps of the teeth are visible, carefully keeping the piece and the file wet with alcohol during the operation. Thoroughly wash the piece with a soft brush in alcohol and place in clove oil for a few hours, or until clear. Then transfer to a very thin solution of balsam in benzole, gradually thickening the solution from day to day by adding pure balsam until the tissues are thoroughly permeated. This is an

* The Microscope, vi. (1886) pp. 128–9.

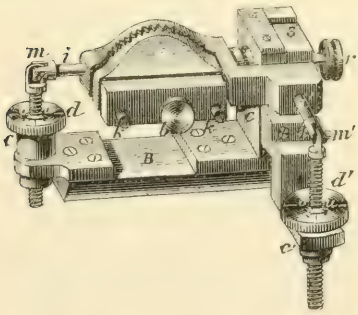
important part of the process, and should not be hurried. Now place the piece in a shallow dish and add pure balsam enough to cover it and evaporate to hardness, being careful not to raise the heat above 110° F. When the balsam is hard the section may be worked down to suit. The balsam will hold the soft parts in position while this is being done. Use water as a lubricant for this part of the work. The section made to suit, dissolve out the balsam with benzole, place in absolute alcohol for a day, clear again in clove oil and mount.

Sections made in this way are necessarily somewhat thick for the reason that the different parts which it is desired to show in the section seldom lie in the same plane, consequently they are best mounted in a cell ground into the slide, which allows the cover-glass to be brought down close. The method may seem somewhat tedious and certainly requires some patience, but the results more than repay for the trouble. Dammar will be found the best medium for mounting.

Henking's Microtome Object-holder for accurately adjusting the Object.‡—Dr. H. Henking's object-holder (fig. 147) aims at giving a measureable rotation to the holder by means of adjusting screws, so that sections may be cut at definite angles to one another.

The clamp *a*, made in a curved form for convenience in holding curved objects and to avoid interference with the knife, is connected with a ball-and-socket joint contained in *e s*, which can be fixed when necessary by the screw *r*. The movable half of the clamp slides upon the guides *k k* and is adjusted by the screw *b*; in the fixed half are two cylindrical holes directed accurately towards the centre of the ball joint. *i* and *i'* are two rods which slide in these holes, and their extremities are hinged at *m* and *m'* to two long screws which are raised or lowered by the nuts *d* and *d'* fixed in position, but free to turn in the collars *c* and *c'*. By means of these nuts, therefore, a rotation can be given to the clamp about either of the axes *i* or *i'*, and may be measured by divisions upon *d* and *d'*. The screw which works in *d* is only half as long as that at *d'*, because the object can be roughly adjusted in this direction in the jaws of the clamp, and *d* is only required for small motions. On the plate which covers the ball-and-socket joint is a vernier scale for indicating the thickness of the sections. By pushing the object-slide along for distances between 1 mm. and 1/40 mm., sections can be obtained without any further assistance than that of a sharp knife.

Fig. 147.



* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 491–6. Cf. Zeitschr. f. Instrumentenk., v. (1885) pp. 314–5 (1 fig.).

Staining.*—Prof. M. Flesch considers the action of staining media; first the inorganic, and secondly the organic.

The action of the *inorganic* salts, silver, gold, iron, may be summed up by saying that the various appearances produced by metallic impregnation are to be explained partly from the physiological condition of the material examined, partly from various chemical affinities to particular tissue elements, and partly to differences in physiological constitution. As examples of the foregoing he gives two illustrations of specimens treated with silver nitrate, one showing a section of cartilage of frog silvered *en masse* with a weak solution of silver nitrate, and the other giving the appearances of quite fresh cartilage of frog silvered in section with the same solution. The differences between the results are to be explained by the greater imbibition capacity of the second kind, and are not to be attributed to chemical differences.

The effect of an *organic* stain is produced either by chemical combination or by surface attraction, i. e. by mere adhesion or infiltration of the stain without chemical union. Examples of the former are to be found in safranin, methyl-violet, &c., in their action on amyloid substance; in borax-carmine on hæmatoxylin; in Merkel's stain for the salivary ducts. An intermediate variety, one consisting partly of infiltration and partly of chemical union, may be found in neutral litmus solutions which stain the cell-substance red and the nuclei blue.

The action of infiltration is dismissed in a few words, as Gierke's published researches have anticipated further remarks. Dr. Flesch, however, urges that the hardening process must count for something in the result of staining processes, and concludes his paper by insisting on the significance of a physical characteristic—the unequal susceptibility for imbibition of the tissues and their elements—and the influence of the fixative changes on this susceptibility from imbibition of organic material.

Weigert's Hæmatoxylin Stain for the Central Nervous System.—Prof. M. Flesch in some comments † on his experience with Weigert's method says that preparations which have been washed in water in the usual way, after coming from Müller's fluid, can be stained, provided the sections (made in celloidin) are treated a few minutes in 1/2 per cent. solution chromic acid, and then, after being washed in water, placed in the colouring fluid. The sections stain very much quicker than by Weigert's method. The decolouring process of Weigert is followed. Creosote is decidedly preferable to xylol as a clarifier.

According to Dr. C. S. Minot,‡ Weigert's hæmatoxylin method may be used after any method of hardening and cutting, provided the sections are treated 5–15 minutes in 1 per cent. bichromate of potas-

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 464–77 (2 figs.).

† Ibid., i. (1884) pp. 564–6.

‡ 'Whitman's Methods in Microscopical Anatomy and Embryology,' 1885, p. 192.

sium, then washed in water, and transferred to the staining mixture. Instead of bichromate of potassium, the following mixture may be used with equal success, but with somewhat *different* results:—Water, 100 ccm.; alum, 1 grm.; bichromate of potassium, 1 grm.

Weigert's Improved Method for the Central Nervous System.*—Prof. C. Weigert's method has been adopted everywhere with great rapidity, as it offers advantages exceeding those of other methods. One of its imperfections (which has been obviated by Prof. Flesch) is that it is only applicable to preparations which have become browned by the action of chrome salts. Another is that it does not stain so many fibres (in the cerebral cortex for example) as can be shown by Exner's osmium method. Prof. Weigert has accordingly made some further improvements which obviate this objection. The new process is as follows: —

1. The pieces fastened to a cork with celloidin are immersed in a solution of copper oxide (a saturated filtered solution of this salt diluted with an equal volume of water) and allowed to remain in an incubator for two days. It does not matter if the pieces are still brown or have become green, so long as they were once brown. Moreover, if they have lain in alcohol for some time, a surface precipitate is not so easily thrown down. After the copper treatment the pieces become green, the celloidin blueish green. They may now be preserved in 80 per cent. alcohol.

2. For staining the sections the hæmatoxylin solution is now modified by adding a slight quantity of some alkali; it is a matter of indifference which; this addition gives it a brownish violet tone. The proportion of a saturated alkaline solution is one to one hundred of the logwood solution. In this solution the sections are placed, and owing to the action of the copper no incubator is needed. For cord sections two hours suffice; brain preparations require an immersion of twenty-four hours, in order that the fine cortical fibres may be stained. The staining solution can only be used once.

For differentiation the borax and prussiate solutions must be diluted with an equal volume of water.

Skatol and Carbazol, two new Reagents for Woody Fibre.†—Dr. O. Mattirolo proposes skatol and carbazol as substitutes for phloroglucin and indol as tests for wood fibre. Both of these bodies give identical reactions, i. e. they impart a violet red colour to ligneous tissue. Carbazol is doubly recommended, as it is found in commerce, and is almost altogether without odour; while skatol is so offensively malodorous that this property of itself is almost sufficient to bar its use in micro-chemistry. Carbazol, one of the products of crude anthracene, boiling between 320° and 360°, is produced in the manufacture of anilin from coal. Skatol is obtained from human fæces or by synthesis in the dry distillation of nitrocuminate of barium.

The author has demonstrated microscopically that skatol and

* Fortschr. d. Med., iii. (1885) p. 236. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 399-401.

† Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 354-5.

carbazol impart a red violet colour to ligneous tissue. Sections are immersed in an alcoholic solution of these bodies for a few minutes, and having been placed in a drop of hydrochloric acid are thus examined under the Microscope. The reaction begins at once and increases in intensity after a short time. The stain, like that of phloroglucin and indol, unfortunately is not permanent. The author mentions that piridina and chinolina also give the characteristic reaction.

New Fixative Medium.*—Herren C. Born and G. Wieger have found a new medium in quince-juice for fixing serial sections or for staining sections on the slide. This is free from the objections inherent to Giesbrecht's shellac medium, Mayer's white of egg fixative, or Schällibaum's mixture of collodion and oil of cloves.

The fixative is prepared by adding to every two volumes of quince-juice one volume of pure glycerin and a little carbolic acid to prevent the formation of fungi.

The medium is applied by spreading a thin layer upon a slide; the paraffin-imbedded section is then placed thereon, and without any haste, as the glycerin prevents the adhesive layer from drying too quickly. Excess of the fixative medium should be wiped off with a clean cloth in order to prevent the section from moving about. The slide is then dried in a warm chamber at a temperature of 30°–40° C. for twenty minutes or longer. On its removal the water is found to have disappeared by evaporation, and the paraffin in a smooth layer. The paraffin is then dissolved out in turpentine and the slide is then transferred to absolute alcohol for half an hour at least. After the alcohol bath the section may be stained with any kind of dye, anilin colours for choice; it is then washed with water or spirit and cleared up in the usual way. Throughout the process the adhesion remains perfect and the fixative does not take up a trace of colour. Even under the Microscope the fixative can scarcely ever be perceived.

There are two points in this manipulation which it is necessary to observe very strictly; the first is that the slide must be perfectly clean, otherwise the fixative may fail to adhere properly. It is recommended to lay the slides for half an hour in cold soap and water and dry them carefully with a clean cloth. The second point is that in transferring from absolute alcohol to a watery staining or washing fluid, the slide must always pass through at least one intermediate stage of alcohol, i. e. alcohol of 50°, otherwise the violence of the diffusion currents may be too strong for the fixative and cause the section to become separated from the slide.

Chlorophyll for Staining.†—To the numerous vegetable products applied to staining, Dr. N. Trinkler adds chlorophyll. He obtains it from the leaves of *Syringa vulgaris* by extracting for twenty-four hours with alcohol, evaporating the filtered extract to dryness and dissolving this in water. The filtrate is a dark green with a trace of brown in it.

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 346-8.
† Arch. f. Mikr. Anat., xxiv. (1885) p. 174.

Staining with Phenol and Logwood.—Mr. C. H. Hughes writes us as follows:—

"Phenol has now and then been referred to, but there seems to be some doubt as to its value. It is said to destroy delicate tissue and bacteria. I cannot speak decisively with regard to the bacteria, but it has no ill effect whatever on the most delicate tissue, and since I have used it successfully in staining and mounting spermatozoa (human and animal), I am entitled to think it does not destroy bacteria, which are hardly more delicate, though of course it kills them.

I put some chips of logwood in phenol, and in about half an hour have a dark-brown fluid, which stains with great rapidity, and no deposit as with the alcohol and aqueous methods. A small quantity of bicarbonate of soda dissolved in water is mixed with phenol, depositing copiously but leaving some still in solution, and kept as developer. The logwood stain is poured off the section and a few drops of the soda solution poured on, when a magnificent purple is developed. Young bone and attachments of muscles are wonderfully set off. Nigrosin, about 5 grains to an ounce of phenol, is unsurpassed for central system, and seems to act more much powerfully than with spirit. I have been trying for some years to effect solution of carmine in phenol. If a good solution like that of hæmatoxylin and nigrosin could be effected, no other dye would be needed by the histologist—for tissues, at least.

If films of bacteria, or of spermatozoa, are exposed to Erlicki's fluid or some of the chromic solutions for a primary effectual coagulation of the albumen, I am satisfied the two dyes named would be efficient in strongest solution."

Staining Pneumonia-cocci.*—Dr. Ribbert recommends the following for cover-glass preparations, viz.:—100 parts water, 50 absolute alcohol, 12 per cent. glacial acetic acid, dahlia to saturation.

The covers are only just touched with the above, washed in water, and examined. Mounted in glycerin or balsam, the cocci appear deep blue, while the capsules are a pale blue. The stain does not last more than a few months. This method is unsuitable for sections.

Staining Recurrens Spirilla in Blood-preparations.†—Dr. K. Günther "fixes" very thin layers of spirilla-blood either in the flame of a spirit-lamp or in a thermostat (5 minutes), at a temperature of 75° C. Only basic solutions of anilin dyes made with anilin water were found to have any staining power. Of these, gentian violet was found to give the most intense stain (100 cc. anilin water, 11 cc. saturated alcoholic solution of gentian violet). Before staining, it is necessary to wash the cover-glass in a solution of 5 parts acetic acid to 100 parts water for 10 seconds, and after blowing off the greater part of the acid fluid, to neutralize the rest by holding the cover-glass over an open bottle of liquor ammoniæ fort. for a few seconds. If this be not done, the deep staining of the blood-plasma and corpuscles will prevent all but a very few spirilla from being seen.

* Deutsch. Med. Wochenschr., 1885, p. 136.
† Fortschr. d. Medicin, iii. (1885) p. 379.

After the acetic acid process, the covers are immersed in the gentian violet solution for a few seconds only, then washed carefully in water, and finally mounted in xylol balsam.

Staining Capsule-Cocci.*—The difficulty experienced in staining capsule-cocci arises from the fact that the ground-substance of the preparation is so deeply coloured that the enveloping capsule is invisible, although the cocci can be discerned.

This difficulty Dr. C. Friedländer points out may be obviated by first passing the preparation thrice through the flame of a spirit-lamp, and then immersing for one or more minutes in one per cent. acetic acid. The superfluous acid fluid is blown by means of a pipette, and the preparation dried in the air is placed in the gentian violet solution (100 cc. anilin water, 11 cc. saturated alcoholic solution of gentian violet) for a few seconds, washed with water, and examined. By this process the ground-substance remains colourless, while the capsules, if any, stand out quite prominently. By cautious treatment with weak acetic acid or alcohol, the characteristic form of the sphærobacteria sometimes appears, for the staining of the capsules is less resistant to both of these reagents than that of the bacteria themselves. In the majority of recent cases of fibrinous pneumonia, capsule-cocci can be found in the manner above indicated, but within the pneumonic exudation other Micrococci forms appear, chiefly Diplococci. These forms may be distinguished from capsule-bacteria both by the want of capsule and also by their smaller dimensions.

After-Staining by the Haidenhain Method.†—Prof. W. Flemming states that preparations made by this method may be much improved by after-staining with Grenacher's alum-carmine or with Delafield's or Böhmer's hæmatoxylin. The blackened pieces, as small as possible, are after being washed in water to be immersed in the stain for two or three days, and then before cutting are to be further hardened for some hours in absolute alcohol. Sections of mucin glands stained with hæmatoxylin show a beautiful violet colour on these cells. It may be remarked that for successful staining the blackening should not be too intense.

Nuclear Stain in Osmic Acid Preparations.‡—The objection is often raised that hardening in pure osmic acid is an impediment to good staining. This inconvenience Prof. W. Flemming finds may be obviated by an after treatment with bichromate of potash, when a good stain is effected by means of Böhmer's or Delafield's hæmatoxylin. After treatment with bichromate is, however, unnecessary if the osmic acid preparations are not kept too long in alcohol, and have not become too much darkened. They are best stained before they are transferred to alcohol. Alum-carmine also gives a good stain with osmic acid preparations in twelve to twenty-four hours. The author uses a 1 or 2 per cent. watery solution (not the vapour) of osmic acid, and hardens in the dark for about six hours, and mounts in glycerin.

* Fortschr. d. Medicin, iii. (1885) p. 380.
† Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 517–8. ‡ Ibid., pp. 518–9.

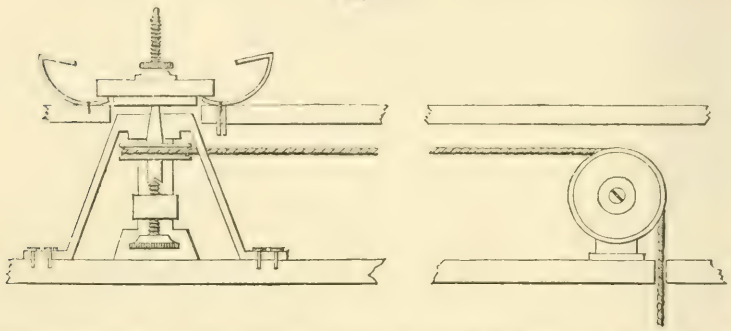
Demonstration of Goblet-cells.*—For this purpose, Prof. W. Flemming recommends not only hæmatoxylin, which imparts a deep blue or violet colour to the contents of the goblet-cells in osmium preparations, but also the osmium mixture† followed by staining with gentian or safranin. The cell-contents then appear blue or reddish brown, and stand out sharply even under low powers.

Horizontal Lathe for Grinding and Polishing hard Objects.‡—Prof. A. Eternod has a grinding lathe by which hard objects are more easily prepared than by the ordinary grindstone or the dentist's polishing lathe. Its main feature consists in being horizontal, and it is hence very convenient to manipulate.

It is made from the table of a sewing machine with its wheel and pedal. The movement is communicated by means of an endless cat-gut band running round a system of wheel pulleys. The details of the machine will be understood from fig. 148.

Prof. Eternod uses emery plates and Arkansas and Turkey stones

Fig. 148.



for grindstones. The Turkey stone is recommended on account of the fineness of its grain for giving a perfect polish. Drainage of the fluids employed for moistening the stones is effected by means of a zinc plate provided with an overflow pipe. The plate also serves to collect the sections as they leave the grindstone, and prevents the operator from being splashed.

Various kinds of Slides.§—Dr. O. A. Wall describes the various kinds of slides in use, commencing with the ordinary 3 in. by 1 in., and the so-called "French" paper-covered slides $2\frac{1}{4}$ in. by 3/4 in.

Sections of minerals are frequently mounted on special sizes of slides, which are wider and shorter, or about 2 in. by $1\frac{1}{4}$ in., so as to allow a larger cover-glass to be used, and at the same time to be more easily rotated with the stage of the Microscopes made for lithological work, when the sections are to be examined with the polariscope. These

* Zeitschr. f. Wiss. Mikr., ii. (1885) p. 519.

† Cf. Zeitschr. f. Wiss. Mikr., i. (1884) p. 349, and this Journal, v. (1885) p. 554.

‡ Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 507–9 (3 figs.).

§ St. Louis National Druggist, viii. (1886) pp. 24 and 39.

larger slides are occasionally of use when it is desirable to mount whole sections of thick rhizomes, roots, and similar preparations.

Some German workers prepare their slides by cementing very narrow strips of glass across the two ends of the slides, so that when the slides are laid upon each other, these strips prevent one slide from injuring the next one, and the slides may be packed away without having the ordinary grooved boxes. These slides, however, says Dr. Wall, "are not often employed in this country, for while it is true that they offer some practical advantages, they are anything but pretty in appearance, and it seems to be a pity to mount a good preparation in such a shabby manner."

"Some ornamental effects in mounting are obtainable by using coloured glass for the slides. For opaque mounts, slides of very dark-blue glass (pot-metal) present a fine background. A pretty effect is produced with some opaque objects mounted on these dark-blue slides, by illuminating with the bull's-eye lens, and at the same time reflecting the light upwards with the mirror, thus showing the brightly illuminated object on a rich blue ground. This method is very pleasant to the eyes. If the light is not reflected upwards with the mirror, such slides appear perfectly opaque and black.

Another pretty kind of slide may be made by cutting the slides from coloured glass (flashed metal), and then painting a heavy circle with varnish on the centre of the slide on the flashed side by the aid of the turntable, and then, when dry, placing a drop of hydrofluoric acid in the centre of the ring, and making a circular spot of clear glass on which the preparation may be mounted. By having slides of red, yellow, blue, purple, and other colours, prepared in this manner, quite a pleasing variety may be given to the appearance of a collection of mounted specimens. The roughness of the glass produced by the acid disappears when the preparation is mounted in balsam, and, in fact, this kind of slide should only be used for balsam mounts for low powers.

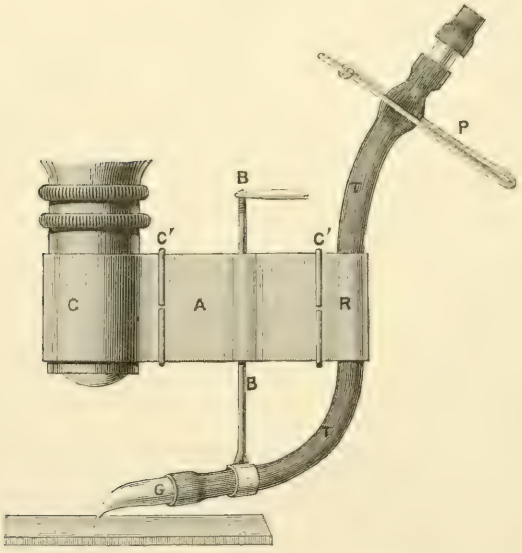
Still another, and very pretty slide, may be made by giving one side of a plain glass slide the appearance of ground glass, by grinding on a slab of plate glass with emery flour and turpentine. The preparation is to be mounted on the ground side with balsam. This kind of slide, like the last, is only to be used for objects for low powers. For some preparations, which should not be subjected to pressure, glass slides may be obtained, on one side of which depressions are ground, in which the object may lie when the cover-glass is put on. These slides are to be preferred to cells for fluid mounts in many cases, but as they are expensive, they are not as frequently used as they would be if they were sold at more reasonable prices. This might readily be done, we should think, as the grinding and polishing of these depressions is not so very expensive. The writer once had such depressions ground in a few hundred slides at 1½ cents per slide; and even at twice or three times this price they would still be cheap compared with the prices commonly asked for them. As they are so convenient for many purposes, it is to be hoped that they may be obtainable at more reasonable prices."

Cleaning Slides.* — Dr. F. L. James takes a wide-mouthed (12–14 oz.) jar, of sufficient depth, and half fills it with a mixture of gasoline or benzine, spirits of turpentine, and benzol. The slides are dropped into this and left overnight. When ready to wipe them, take out each slide separately, and give it a good hard wipe with a piece of muslin, and then polish with another clean bit of the same stuff. "Try the plan once, and you will never use any other. Slides thoroughly cleaned thus possess a quality which, in making glycerin or aqueous mounts, is absolutely invaluable. While they are optically and practically clean, such slides retain upon their surface an exceedingly tenuous film of resinous matter that prevents water or glycerin from attaching itself to the surface, and the consequence is that the surplus of such fluid, after a cell is closed, rolls off the slide without moistening it in the least. Cement, on the contrary, attaches itself with extraordinary firmness and evenness."

Apparatus for Sorting and Arranging Objects.—Mr. J. Hippisley suggests the apparatus shown in fig. 149 for sorting and arranging microscopic objects.

A broad piece of sheet metal A is formed into a clip C at one

Fig. 149.



end so as to slide over the objective and into another at R to hold a flexible indiarubber tube T. This tube has at the lower end a curved glass tube G terminating in a very fine capillary point which nearly touches the slide. By raising or lowering the rod B B

* The Microscope, v. (1885) pp. 253–4, from St. Louis National Druggist.

the vertical distance of the tube G can be regulated. The adjustment of G to the centre of the field is obtained by turning B B. Two sliding clamps C′ C′ serve to tighten C and R.

The apparatus can be used either for directing moisture from the mouth on the objects on the slide, and temporarily securing them until finally mounted, or by adding a wire clip at P and pressing the tube T below that point with the thumb and finger, the tube can be used as a syringe, so that it can be made to take up or emit a drop of fluid.

The flexibility of the tube obviates the danger of any breakage by overpressure of G on the slide.

Mounting several Groups of small Microscopic Objects under one cover.*—Mr. S. G. Shanks gives the following directions for mounting pollens, which will also suffice for other small objects:—

The pollens should be gathered from freshly opened flowers, and may be teased from the anthers with a needle into small bottles, which, after the pollen is thoroughly dry, should be kept corked.

Prepare a card marked with three, four, or five spots, all arranged within the limits of a 3/4 in. cover-glass, place a glass slip upon the card, and put a minute drop of turpentine on the slip over one of the marked spots. A needle with a little turpentine on it will serve to convey a small amount of pollen from the bottle to the drop of turpentine on the slip. Cohering masses of pollen should be separated with the needle and spread as evenly as possible over 1/8 in. of space on the slip. A small drop of balsam, just sufficient for the purpose, is then dropped on the pollen.

The next specimen of pollen is similarly arranged over another spot, and a small drop of balsam applied as before. When the several pollens are in place the slide should be set aside and covered from dust for twenty-four or forty-eight hours, or until the balsam has become somewhat hardened and the pollens fixed in their respective places. A drop of fresh balsam may then be placed in the centre between the groups and a cover applied with very gentle pressure, and all allowed to harden as usual. If the first balsam drops are not sufficiently hard when the cover-glass is adjusted, the fresh balsam will liquefy all too rapidly, and the pollens will run together or creep out with the surplus balsam. Two strong a pressure will also cause the pollens to mix by producing currents in the balsam as the cover settles into place.

The names of the flowers from which the pollens are gathered should be written on the label in small characters and occupy the same relative positions as the specimens do under the cover. This will enable one to find a given specimen or name quickly.

This method may be employed for Foraminifera, seeds, diatoms, scales, or any other small objects which might be placed together for the purpose of comparison.

Cassia Oil for Mounting.—This medium has already been recommended for immersion and probably also for mounting, though we

* Amer. Mon. Micr. Journ., vii. (1886) pp. 64–5.

are not aware of the fact. Mr. A. C. Cole recently brought us some slides of *Heliopelta*, *Coscinodiscus*, *Trinacria*, and *Triceratium*, mounted in this medium, which (at any rate for the diatoms in question) prove that cassia oil can hardly be surpassed as a mounting medium. The clearness with which the markings are shown is very remarkable.

The refractive index of cassia oil is about 1·640.

Mounting with Carbolic Acid.*—Mr. T. Steel has varied somewhat the process of carbolic-acid mounting, described by Mr. J. R. Y. Goldstein.†

If the object is an insect, it is treated with potash or soda in the usual manner, to render it transparent; it is then rinsed in water and passed into spirit. The carbolic acid is prepared as follows:—Take, say, 1 oz. of Calvert's pure solid acid, and melt it by placing the bottle in warm water; when thoroughly fluid, add about 30 drops of spirit, shake well, and allow to cool; if it crystallizes again, melt as before, and add 10 or 15 drops more spirit, and again shake and allow to cool. Now melt a portion of balsam on the slide, and remove air-bubbles; heat the balsam until it is sufficiently evaporated to become firm on cooling; allow to cool. Place three pieces of thin wire as supports for the cover-glass. In the meantime the object should have been removed from the spirit and placed in a short test-tube containing some of the carbolic acid, and allowed to soak until quite saturated; or it may be gently boiled, which is the quickest way. When boiling, the tube should be kept shaken. A few seconds is all the heating required. This boiling is a capital way of getting rid of air-bubbles, and, if necessary, the tube should be allowed to cool and again heated, and this will seldom fail to displace any persistent bubbles. The object being now thoroughly permeated by the acid, the tube is allowed to cool. A drop of carbolic acid is now placed on the surface of the hard, cool balsam on the slide by means of a dipping-tube; the object is then taken out of the tube on a mounted needle, or the contents of the tube emptied into a little dish, and the object taken out and at once placed in the drop of acid on the slide and arranged as desired. The cover-glass is taken in the forceps, and a drop of the acid spread on its under surface. Should any air-bubbles appear in this drop of acid during the spreading, they are best got rid of by holding the cover-glass for a moment over the lamp. The cover-glass is held in place by a light wire clip; and the excess of acid absorbed by bibulous paper.

When the excess has been absorbed, the slide is gently warmed, and as the balsam softens, the spring clip presses the cover-glass down into position. The slide, with the clip still on, is baked in the usual manner. Six to twelve hours is sufficient baking for most slides, but that depends on the degree to which the balsam has been evaporated before placing the object. When the operation of baking has been satisfactorily accomplished, the slides are allowed to cool, always keeping on the clip till they are quite cold.

* Scientif. Enquirer, i. (1886) pp. 41–3.

† See this Journal, iii. (1880) p. 858.

Turntable Improvements.*—Mr. E. H. Griffith writes:—"Turn a disc of zinc-white cement on the centre of the turntable and when hard, ring with pen and ink. For centering purposes the white centre is of great value. The cement can easily be removed with benzole at any time if desired."

Cover-glasses in the Tropics.—Mr. J. C. Douglas writes from Calcutta:—"We find it very difficult here to get good cover-glasses; they rapidly become frosted and worthless. They appear to be of a soft lead glass. Would not a green hard glass be more likely to stand? If you could give any information as to how to get good covers it would be a great service to many. The glasses commonly arrive unfit for use, so that instructions as to keeping them in spirit, acid, or other medium are useless. I think it probable green covers would stand and be preferable in other ways from the greater resistant powers of the green as compared with the soft glass."

Mr. T. Curties informs us that repeated complaints from Indian correspondents were referred to Messrs. Chance Brothers who were unable to provide a harder thin glass. They recommended its being packed and kept in lime; no good result followed the use of this, or of French chalk which was also tried. Both rendered the surface deposit harder than ever and more difficult to remove. The last experiment tried was with clove oil, and this has proved quite successful. Dr. Plaxton of Colombo, who suggested its use, writes:—

"I think we have hit upon the right mode of preserving cover-glass. I used some yesterday, now two months since it was received, and it was in perfect condition."

Cover-glass Cement.†—Dr. L. Heydenreich gives the following approximate formula for cover-glass cement:—Amber, 25 parts by weight; copal, 25 do.; linseed oil boiled and with addition of manganese borate, 50 do.; oil of lavender, 50 to 60 do.; artificial cinnabar, 40 to 60 do. The following directions are given for preparing the cement in small quantities (one or two pounds). The amber resin finely divided is put into a tall glazed vessel and dissolved by the aid of heat in a sand-bath. When perfectly melted, the linseed oil, previously raised to its boiling-point, is added. When the two are well mixed they are poured back into the vessel in which the oil has been heated. 0·25 per cent. manganese borate is added and the whole allowed to boil gently for two hours. When the mixture has cooled down to about 70°, so much oil of lavender is added as will render it of a syrupy consistence. The whole is then put aside for a week or two until it has cleared up. The copal is prepared in a similar manner. The two varnishes are mixed together and then the cinnabar is thoroughly rubbed in. The cement is then poured into stoppered bottles or collapsible tubes. If the varnish should become too thick, it may be thinned down by working a little ol. lavandulæ into the quantity required for immediate use.

Prepared in the above manner and, so to speak, for home con-

* The Microscope, vi. (1886) p. 83.

† Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 333–8.

sumption, the cement will always be more or less dark. Perfectly clear, sherry-coloured varnish can only be obtained by going through a series of solutions which are only suitable for the preparation of large quantities.

Amber-lac for closing Microscopical Preparations.*—Dr. W. Behrens recommends amber-lac for ringing round cover-glasses, closing preparations, &c. The first kind, a commercial preparation, he used was probably made from broken up amber-refuse, but it must have contained other constituents as it was of a dark olive-brown colour. In bulk it was opaque, but in thin layers on glass had a beautiful amber tint. The solvent, judging from the smell, was, principally at least, linseed oil. Two other kinds marked J and O were also examined. O was a fluid of a bright cognac colour. J was a brownish black liquid quite non-transparent.

Specimens closed with this medium were found to be perfectly hard in about a week, and when submitted to severe tests gave evidence of tenacity. The specimens used were vegetable preparations mounted in glycerin.

Why do Dry Mounts Fail?†—Miss M. A. Booth, in looking over her collection of slides, representing the work of European and American preparers, with a view to noting their keeping qualities, has been so surprised at the number of failures as to query whether permanence in microscopical work is possible. Why is it that so large a proportion of dry mounts fail? Obviously because that motto which should emphatically be the microscopist's motto, *festina lente*, is not heeded by all workers. The advances in the merely mechanical portions of mounting have evidently not kept pace with those in its purely scientific departments, or else microscopists sometimes forget to take counsel of their good common sense in the use of cements. In her collection are slides which have cost hours of skilful manipulation and yet are utterly ruined because of inattention to the details of the proper use of a cement. How do we sometimes apply balsam to a mount? By running it under the cover and trusting to capillary attraction to fill the field. But why should this law of capillary action be operative in the case of the balsam and suspended in that of the cement? From careful observation and a not limited experience—speaking of dry mounts of diatoms and the like—Miss Booth is convinced that success or failure depends not so much upon the kind of cement used, as upon the care with which it is used.

In her own work, however, she has fixed upon white zinc as the most reliable cement, and has sent out hundreds of slides made with this cement, accompanied with the request that all failures be returned, so that she might replace them with perfect slides; but not a slide has ever been returned. It has been her experience that white zinc properly prepared and properly used never fails. The secret of success with good white zinc is, that the rings shall be

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 54–7.
† Micr. Bulletin (Queen's), ii. (1885) pp. 17–8.

thoroughly dry, prepared at least forty-eight hours, and preferably more, before using. It may be objected that so much drying consumes too much time. Slides can be ringed at the rate of a gross an hour, and this at odd moments when no other species of microscopical work is possible. These slides, packed in rack boxes, occupy but little space, are free from dust, and reliable slides are always ready for immediate use. In deep cells for opaque mounts, it is not found that those slides whose cells contain an aperture are any more free from dewy deposits upon the cover than those which are hermetically sealed.

The following form of cell she has found very satisfactory. Use no volatile substance within the cell; paste a dead black paper upon a white (not much glazed, and therefore absorbent) one, and from this cut with a gun-punch disks of the desired size; centre a slide, and paste a disk upon it (black side down), to exclude the light; upon this cement with gold size a brass curtain-ring, flattened or not, according to the depth of the cell required; run on a background with any shade of water-colour paint which best exhibits the object, leaving a white margin around the edge of the cell; cement the cover with a small quantity of white zinc to the ring; colour the cell as may be desired; run on the copal mixture [already described] giving added security to the cover and rounding out the cell. This makes a neat and durable mount, and no dewy deposits have ever, to her knowledge, appeared upon the covers of cells so made.

With regard to the prevention of "dewing" in transparent mounts, she has found it essential that the objects should be thoroughly dry. If diatoms, use the covers direct from the brass mounting table; or if such as have been breathed upon, as scales, see that the moisture is fully evaporated, and in sealing, use the smallest quantity of cement consistent with a perfect adhesion of the cover-glass.

Labelling Slides.*—It is suggested that a good plan is to punch some squares or circles out of very thin talc; cover the end of the glass slip with a thin layer of gilder's whiting and gum-water; when dry, write on this with common ink, let it dry, put a very small drop of Canada balsam upon it; cover with a circle of thin talc, and allow all to dry; then clean the edges with benzole and water mixed. It will not peel off or get dirty like printed labels.

Slide Labels.†—Mr. E. H. Griffiths writes that "very beautiful and very practical labels for Microscope slides may be quickly made with the brush and pen. On the ends of the slides turn smooth discs of good, clear white zinc cement, and with finishing colours border to suit the fancy. With a pen, write or print on the white centre whatever is desired."

Cabinet for Microscopical Preparations.‡ — Prof. A. Eternod describes the cabinet in use at the histological laboratory of Geneva, as being especially suitable for large institutions.

* The Microscope, v. (1885) p. 179. † Ibid., vi. (1886) p. 84.
‡ Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 511–3 (2 figs.).

A cabinet of this sort, constructed to hold about 7000 preparations, consists of a double tier of small drawers, and three larger ones, intended for the accessories of the collection, such as catalogues, drawings, &c. Each drawer is divided into four compartments by

Fig. 150.

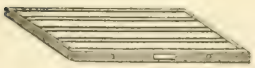


Fig. 151.

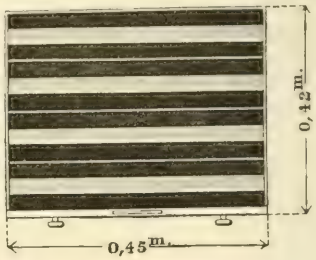


Fig. 152.

thin strips of wood, fig. 150. The floor of each compartment is black with a white stripe running down the middle, fig. 151. This colour arrangement facilitates reference, for the slides are marked with a diamond point, no labels being used. Thus the black band shows up the inscription, the white the specimen. The drawer labels, written on card or Bristol board, are slipped into a groove let into the front of the drawer, fig. 152. Thus the contents of a drawer may be re-labelled with the greatest ease.

The depth of the drawers is calculated to allow for cell-slides.

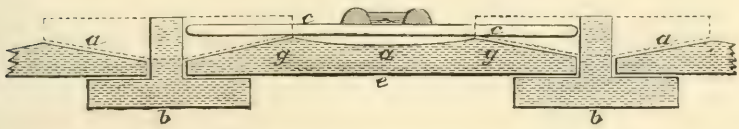
Improved Method of Constructing Slide Cabinets.*—Mr. H. E. Summers' aim in making this cabinet, was to combine the advantages of the different existing cabinets, and at the same time to so simplify the construction that it could be made cheaply and by an ordinary carpenter, with the tools usually at his command. The advantages are:—1. Each slide should have a separate compartment. 2. The slides should be easily removable. 3. They should not rest upon the support immediately beneath the object. 4. They should lie flat while the cabinet is in its ordinary position. 5. They should be so held that the object cannot be injured if the cabinet is overturned in transportation.

The cabinet was intended for slides of the ordinary length, 3 in., but of two widths, 1 in. and 2 in. The drawers are made up of strips or mouldings of two forms. These are shown in section in fig. 153 in the relative position they occupy when joined. A slide *c* is also shown in place. The strips *a a* and *b b* run from the front to the back of the drawer. The slide *c* rests on the two ridges *g g* of the strip *a*. Between the ridges the strip *a* is slightly hollowed, to prevent contact of the slide beneath the object, and consequent soiling. From the ridges to the edges, the strip *a* is levelled, so that one end of the slide may be tipped up by pressure upon the opposite end,

* Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 108-9 (1 fig.).

in order that it may be grasped more readily. The strips *a a* rest in rebates in the strips *b b*. These rebates are of such a depth that when the strips *a a* are in place, the upper surface of one of the thickest slides in use will be just a trifle lower than the top of the strips *b b*.

Fig. 153.



The cover-glass or cell upon the slide may project above the top of the strips *b b*. The object will then extend up into the space *e* of the drawer above. This space should hence be high enough to admit the deepest cells.

The partitions between the sides of adjacent slides are merely short, thin strips of wood, tin, or better, ferrotype plate, set at proper intervals in grooves sawn across the upper part of the strips *b b*. If desired, the portions may be continuous across the drawer, but the short strips seem to serve every purpose, and are more easily inserted. If a cabinet has been entirely divided up for slides 1 in. wide, and it is desired to insert one 2 in. wide, a portion can be removed without in any way disturbing the rest of the drawer.

When these drawers are inserted in a cabinet, the strips *b b* are allowed to slide upon, or at least approach very near to, the corresponding strips of the drawer below. In case of overturning, the slides are held in place by the side projections of the strips *b b* of the drawer above. The two outer strips *b b* of each drawer form the sides of that drawer, the side projections of the strips in this case sliding in grooves in the sides of the cabinet, thus supporting the drawer. In the front and back of the drawer, it should be observed that the part opposite the space *e* must belong to the drawer *below*, in order that the deeper cells may not be injured when the drawers are slid in or out. The irregularity thus produced may be rendered inconspicuous by placing over these portions the porcelain tablets usually used for the numbers of the drawers and of the contained slides.

Transmitting Sections by Post.*—Mr. R. N. Reynolds, having occasion frequently to send sections by post, has successfully used the following plan by which the objects are kept saturated with alcohol without infringing the law forbidding the postage of liquids.

In a wide-mouthed half-ounce bottle a little alcohol is placed, sufficient to saturate the papers used in packing the sections. Some 2 in. squares of tissue paper are then cut, on which the name of the section is written with a lead pencil; on this the section is placed and the paper folded over it, care being taken not to fold the section; the parcel is then dropped into the bottle, resting flat on the bottom.

* Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, p. 124.

Repeat this with as many sections as desired, or until the bottle is filled. In case the parcels do not fill the bottle, complete it by a wad of tissue paper. The bottle may then be posted as usual by boring a hole in a block of wood and packing with paper. The sections are, of course, removed on reaching their destination by unfolding the parcels in alcohol and floating off the specimens.

In the case of very delicate sections it is well to float them into paraffined paper or writing paper; straighten out the folds of the section by holding the folded portion in alcohol and manipulating it with a small red sable brush; then cut away the uncovered portions of the paper and pack as before.

Polarized Light as a means of recognizing Irritable Conditions of the Nerves of the Scalp.*—Dr. J. Pohl-Pincus announces that by an examination of the hair roots by polarized light, peculiar changes may be observed whenever the patient suffers from physical irritation or mental excitement. This statement is the result of investigations which have now been going on for twenty-five years, and the later observations in the course of the research have uniformly confirmed those made earlier.

The hair bulbs are divided into three groups, as follows:—Group A: If, in healthy conditions of the body and mind, the hairs that fall out daily are examined microscopically by polarized light, the enlarged bulbous end of the root will show a white contour, and a yellowish or brownish-red centre. Group B: In all irritable conditions of moderate grade, all painful conditions of any organ, also in emotional disturbances of moderate grade, without any apparent bodily disease, the bulbous end of the hair root increases in length and breadth (in proportion to the irritation), the central part appears under polarized light of a violet, blue, or bluish-green colour, separated from the white contour by bands of yellow and red. Group C: In higher grades of bodily disease or mental disturbance, the bulb becomes still larger, and the blueish centre changes to green, yellow, or orange. A few hairs of the B and C types are found in normal conditions, especially in those more advanced in life. Dr. Pincus gives thirty-one cases showing the effects of painful disease, but more especially of depressing emotions, upon the appearance of the hair root. The conclusion to be derived from these researches is that bodily disease or mental excitement causes circulatory disturbances, and in consequence a change in the normal nutrition and pigmentation of the hair. This is only in accordance with previous observations, and the chief merit of the author's plan lies in his obtaining a means by which very slight and temporary changes in tissue growth can be detected and approximately measured.

Feather-crystals of Uric Acid from a Caterpillar.†—Dr. S. Lockwood prepares these crystals in the following way:—Have ready say, six slides, absolutely clean. Puncture the caterpillar with the

* Lancet, 1886, i. p. 848.

† Journ. New York Micr. Soc., i. (1885) pp. 217-8.

point of a penknife or of scissors: a drop of green liquid will exude. Put some of this on each slide, spreading it out a little so that it shall not be too thick. Place the slides in a temperature of about 70° F., and put over them a piece of paper to exclude light and dust. In about half an hour they should be dry, and, if successful, the crystals, few or many, should be formed. Mount with balsam. If the crystals are *urea*, early mounting is advisable, since their easy solubility might put them in peril, on account of the natural moisture in the air. If they prove to be *urates*, which are not so soluble, the mounting can, if necessary, be deferred.

Preparing Micro-crystals.*—Dr. K. Haushofer points out that, although it is useful to produce microscopical preparations for the purpose of comparison and demonstration, yet it should not be forgotten that a single precipitate or a single crystallization rarely shows all the important forms of a compound, and that, as a rule, the same compound has to be prepared several times, under different conditions, if we desire to obtain a perfect standard of comparison. If we neglect these precautions, and rely merely on a single preparation, we shall occasionally arrive at incorrect judgments.

Many of the chemical compounds are quite unsuited for permanent preparations, as, for example, many salts of silver, mercury, and lead, the majority of the carbon compounds, &c. In most cases it is found to be a more efficacious plan to put up the crystals dry, and protected against dust by a cover-glass fixed by Canada balsam, than to imbed them in a resinous medium. If the nature of the preparation permits, care should be taken to wash away any secondary crystals which might obstruct observation, and also any residues from the precipitant, or from the original solution. This is very often favoured by the circumstance that the micro-crystals of a precipitate adhere pretty firmly to the slide in which the reaction has taken place, and especially when precipitated by heat. It is then merely necessary to put the slide in a sloping position in a vessel of water, and having withdrawn it with care, to allow it to dry in an almost vertical position. If the precipitate does not adhere firmly enough to the slide, the latter is placed in a large test-tube, water is poured over it, and the precipitate allowed to subside. Every drop of the water may be removed by decanting. The precipitate is then placed on a slide, and left just as it is, or the greater part of the water removed by the aid of blotting-paper. Of course, only quite insoluble precipitates tolerate washing without injury to the crystals. Very slight degrees of solubility are recognizable by a roughening of the crystalline surfaces.

Micro-chemical Demonstration of Albumen.†—Dr. O. Loew has employed two tests for albumen, viz. the Berlin blue test and the biuret test. In the Berlin blue reaction the preparations were

* Haushofer's 'Mikroskopische Reactionen,' 1885, pp. 161–2.
† Bot. Ztg., xlii. (1884) p. 273.

placed for an hour in a mixture of 1 vol. aqueous solution of ferridcyanide of potash (1–10) and 2 vols. acetic acid (1 vol. acid sp. gr. 1·063 to 1 vol. water). He then decanted with 60 per cent. alcohol until the fluid no longer had an acid reaction, and no longer became blue on the addition of ferridchloride, and finally placed the preparations in a solution of ferridchloride. By this means the nuclei, starch, and to some degree the chlorophyll-granules (from which the colour had been removed by absolute alcohol) were stained blue, the rest of the protoplasm remaining unstained.

As specially suitable for this method, strips of epidermis from the leaves of *Orchis* are recommended. With *Spirogyra* this procedure does not yield the desired results, although the cell-contents of this alga are rich in albuminoids. The absence of the reaction depends possibly upon some specific arrangement of the albumen molecules; consequently, *Spirogyra* has to be treated by the biuret test, which is done as follows:—The algæ are steeped for 12 hours in a dilute solution of potash and yellow prussiate of potash, and next in a solution of the same salt with acetic acid. After being washed with water, and then in 60 per cent. alcohol, they are finally placed in a dilute solution of iron chloride. Or, instead of the foregoing, the algæ may be placed for 15 minutes in a 25 per cent. solution of potash, and then for an hour in an acid solution of prussiate of potash. Having been washed as before, the chlorophyll is withdrawn with absolute alcohol, and the blueing of the protoplasm effected with ferridchloride solution.

With regard to the biuret test, which consists in the application of copper sulphate and of potash, the author remarks that a rose-colour is imparted to the protoplasm of the older cells if the order of the reagents be reversed.

Micro-chemical Reaction for Demonstrating Reducing Sugars.*—Herr A. Meyer recommends the following procedure:—

Sections, two to four cell-layers thick, of the plants to be examined are placed for a short time in a saturated watery solution of sulphate of copper, then shaken quickly once in water and directly after immersed in a boiling solution of 10 grms. Seignette salt and 10 grms. caustic potash in 10 grms. water. After some seconds, in all the cells which contain reducing sugar, a precipitate of copper oxydul is thrown down while all the other cells remain perfectly colourless. By this method the disturbing formation of copper oxide is prevented, and a more accurate conclusion as to the distribution of sugar in the tissues is possible.

Polarization of Bi-axial Crystal Plates cut vertically to an Optic Axis.†—Flat, optically bi-axial crystals, which are cut vertically to one of the optic axes, must, according to theory, always remain uniformly dark when examined under the Microscope with crossed nicols with one complete turn of the stage. Herr E. Kalkowsky shows that the appearances required by theory are never attained in

* Ber. Deutsch. Bot. Gesell., iii. (1885) p. 332.

† Zeitschr. f. Krystallog. u. Mineral., ix. (1884) pp. 486–97 (1 pl.).

observation, because the simultaneous fulfilment of the following five conditions is demanded:—(1) The plates must be perfectly parallel, have perfectly smooth surfaces, and be composed of quite pure material. (2) The plates must be absolutely vertical to one optic axis. (3) Must be for one kind of light only. (4) The incident light must consist of parallel rays. (5) The Microscope must be absolutely free from defects. As conditions 1 and 2 are only occasionally, and 3, 4, 5 never, fulfilled, theory and practice give contradictory results. Frequently, when thin-ground, section surfaces may be found which remain uniformly clear, and without the appearance of interference colours when examined with crossed nicols. This property of remaining clear between crossed nicols depends on the phenomenon of internal conical refraction. The author then shows how, by means of plates of bichromate of potash, this internal conical refraction can be studied. A plate of this salt is fixed with wax to a rod, and the rod fastened in such a manner that the optic axis lies in the centre of the field of vision. Instead of the lower nicol, a very small diaphragm is inserted. Over the diaphragm a strip of tinfoil, perforated by a tiny hole, is placed, so that the hole lies in the centre of the visual field. The Microscope is then pushed under the bichromate plate, and the diaphragm raised until it is quite close to the plate. The Microscope is fitted with a weak objective and a strong ocular. At a certain focus, instead of the round hole, a bright ring is perceived. The light of this ring is polarized, as may be proved by placing a nicol on the ocular. Hence the author shows that, in spite of theory, a plate cut vertically to one optic axis is always bright between crossed nicols. The internal conical refraction was also examined in topaz, andalusite, staurolith, adular, diopsid, epidote, and arragonite.

Enock's Sketches.—Under this title Mr. F. Enock is issuing lithographic illustrations of some of his slides, the various parts being numbered and named. In addition a short explanation is given, the following being that accompanying sketch No. 3—the head of a ground-bee:—

"This bee belongs to Section 2 of the British Aculeate Hymenoptera, in which the hairs on the body, &c, are more or less branched or plumose, especially those on the legs of the present example, *Colletes Daviesana*.

The tongue (10) is short and bifid, a good type of the Obtusilingues.

The labial palpi (11) are hidden away under the lingua (10), and cannot be seen from the upper side. The paraglossa (8) are two small organs, having a few strong hairs on the margin, situate on the upper side, and at the base of the lingua (10).

These bees burrow in the sand, using their mandibles (5) for this purpose, and wear the tips quite blunt by the time they have completed their work.

This head is specially prepared for the paraboloid, but by carefully illuminating with the 'silver side reflector,' the puncturation on the face, &c., can be well brought out."

It is intended to issue sketches of all the mouth-organs of British bees and other interesting insects. Such sketches will undoubtedly be of great value to scientific students.

We have before had occasion to commend the practice of supplying with slides an explanatory description of the object, thus enabling the microscopist to take an intelligent interest in what he sees. We hope Mr. Enock will find an adequate reward for his enterprise.

Francotte's Manual of Microscopical Technique.*—While there are a profusion of works in German dealing with microscopical technique, the number written in either English or French is very limited, and Dr. Francotte's book will be welcomed by a considerable number of practical microscopists who read French.

The first part contains an excellent statement of the modern optical theory of the Microscope—one of the best that has yet appeared—with descriptions of instruments. The second part deals with fixing, hardening, staining, and other reagents, and with methods of investigation. A special feature of this part is the tables showing in a convenient analytical form the course of the various processes. The third part contains a variety of practical "exercises" for the student in histology, embryology, zoology, comparative anatomy, &c. Throughout the book descriptions and illustrations are given of accessory apparatus, microtomes, &c. The only unfavourable remark that we can make is that some of the original illustrations are unusually rough, but this, as always, is no doubt to be laid to the door of the publisher, and not the author.

ANDEER, J.—**Das Resorcinderivat Phloroglucin.** (The resorcin derivative phloroglucin.) [*Post.*]
Internat. Monatsschr. Anat. u. Histol., I. (1884) pp. 350–3.
Centralbl. Med. Wiss., Nos. 12 and 33, pp. 193 and 579.

ARTHUR, J. C., C. R. BARNES, and J. M. COULTER.—**Handbook of Plant-dissection.**
[Contains a chapter on instruments, reagents, section-cutting, mounting, &c.]
xxii. and 256 pp., 2 pls. (12mo, New York, 1886.)
Cf. *Nature*, xxxiv. (1886) pp. 261–2.

BARNES, C. R.—See Arthur, J. C.

BARRETT, J. W.—**The Preparation of the Eye for Histological Examination.** [*Post.*]
Quart. Journ. Micr. Sci., XXVI. (1886) pp. 607–21.

BEHRENS, T. H.—**Sur l'analyse microchimique des minéraux.** (On the microchemical analysis of minerals.)
Ann. de l'École polytechnique à Delft, 1885, p. 176.

Benda.—**Modified Hæmatoxylin Method.** [*Post.*]
Nature, XXXIV. (1886) p. 236,
(transl. of *Proc. of Berlin Physiol. Soc.*, May 28).

Biggs, H. M.—See *Hüppe, F.*

BIZZOZERO, G.—**Ueber den Bau der geschichteten Pflaster-epithelien.** (On the structure of stratified epithelia.) [Methods. *Post.*]
Internat. Monatsschr. Anat. u. Histol., II. (1885) pp. 278–83 (1 pl.).

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* Francotte, P., 'Manuel de Technique Microscopique, applicable à l'Histologie, l'Anatomie Comparée, l'Embryologie et la Botanique,' viii. and 433 pp., 110 figs., 8vo, Bruxelles, n.d. (1886).

Blish, W. G.—**Preserving Paste Eels.**

[To preserve paste eels, the paste should be kept in a wide-mouth bottle, loosely stoppered, placed in a cool place. If the eels are not doing well, add a piece of bread, or prepare some fresh paste, preferably of rye flour. Paste containing a good supply of eels will keep for weeks without moulding.]

Amer. Mon. Micr. Journ., VII. (1886) p. 78, from *Scientif. American.*

Born, C., and G. Wieger.—**Ueber einen neuen Unterguss.** (On a new fixative.) [*Supra*, p. 711.] *Zeitschr. f. Wiss. Mikr.*, II. (1885) pp. 346–8.

Brauns, R.—**Ueber die Verwendbarkeit des Methylenjodids bei petrographischen und optischen Untersuchungen.** (On the applicability of methyl-iodide to petrological and optical investigations.) [*Post.*]

Neues Jahrb. f. Mineral. Geol. u. Palæontol., 1886, II., pp. 72–8.

Brayley, E. B. L.—**The Natural Preservation of Rotifera and other Pond Organisms.** [*Post.*] *Sci.-Gossip*, 1886, pp. 149–50.

Brevoort, H. L.—**Fur Fibres as shown by the Microscope.**

3 pp. and 14 pls. (4to, New York, 1886).

Cf. *Journ. N. York Micr. Soc.*, ii. (1886) pp. 69–71 (1 pl.).

Brittan, W. C.—**Sections of Teeth.** [*Supra*, p. 707.]

The Microscope, VI. (1886) pp. 128–9 and 134.

Bütschli, O.—**Einige Bemerkungen über gewisse Organisationsverhältnisse der sogenannten Cilioflagellaten und der Noctiluca.** (Some remarks on certain relations of the so-called Cilioflagellata and Noctiluca.)

[*Ante*, p. 460, and *supra*, p. 703.]

Morphol. Jahrb., X. (1885) pp. 529–77 (3 pls. and 4 figs.).

C.—**Examining rare fluids containing crystals or lymph.**

[For examining rare fluids containing crystals or lymph, place a little in an ordinary vaccine tube, as supplied for taking lymph off a child's arm, seal the ends in a gas flame, taking care not to heat the fluid. Next take a slip of cardboard (thin) about the size of a glass slide, cut out a space in the centre in the shape of a diamond, place the tube, which is about 1/16 in. in diameter, over the centre of the card, and gum a strip of gummed paper across the tube, leaving the ends to project past the strip.]

Scientific Enquirer, I. (1886) p. 56.

Carnoy, J. B.—**Karyokinesis in Arthropods.** [*Post.*]

Amer. Natural., XX. (1886) p. 578, transl. from 'La Cellule' (Louvain, 1885).

Cement, Insoluble.

[Take of gum shellac, 3 parts; indiarubber, 1 part; by weight. Dissolve the rubber and shellac in separate vessels in ether, free from alcohol, applying a gentle heat. When thoroughly dissolved mix the two solutions, and keep in a bottle tightly stoppered. This glue resists the action of water, both hot and cold, and most of the acids and alkalies. The addition of not over 2 per cent. of potassium bichromate to a solution of glue, and subsequent exposure of the glued parts to the sunlight, will make an insoluble cement.]

Scientif. Enquirer, I. (1886) p. 110, from *Scientif. American.*

Cole's (A. C.) New Slides. [*Supra*, p. 717.] *Sci.-Gossip*, 1886, p. 139.

Coulter, J. M.—See Arthur, J. C.

Ehrlich, P.—**Ueber die Methylenblaureaktion der lebenden Nervensubstanz.** (On the methyl-blue reaction of living nerve-substance.) [*Post.*]

Biol. Centralbl., VI. (1886) pp. 214–24.

Deutsch. Med. Wochenschr., 1886, No. 4.

Cf. also *Centralbl. Med. Wiss.*, 1885, pp. 113–7.

„ „ **Hämatoxylinlösung.** (Hæmatoxylin solution.) [*Post.*]

Zeitschr. f. Wiss. Mikr., III. (1886) p. 150.

Fischl, J.—**Erfahrungen über einige neue Untersuchungsmethoden des Gehirns.** (Experiments with some new methods for the brain.) [*Post.*]

Prager Med. Wochenschr., 1886, No. 2.

Wiener Med. Wochenschr., 1886, No. 5.

FLINT, J. M.— **On the Collection and Method of studying Foraminifera.**
[Cf. *ante*, p. 133.] *Amer. Mon. Micr. Journ.*, VII. (1886) pp. 105–8.

FRANCOTTE, P.—**Manuel de Technique microscopique applicable à l'histologie, l'anatomie comparée, l'embryologie et la botanique.** (Manual of microscopical technique applicable to histology, comparative anatomy, embryology, and botany.) [*Supra*, p. 728.]
viii. and 433 pp., 110 figs., 8vo, Bruxelles, n.d. (1886).
Cf. E. Rouffart, *Bull. Soc. Belg. Micr.*, XII. (1886) pp. 82–7.

FRENZEL, J.—**Ueber die Mitteldarmdrüse (Leber) der Mollusken.** (On the mid-gut gland (liver) of the Mollusca.)
[Methods, *post*. Cf. also this Journal, V., 1885, p. 792.]
Arch. f. Mikr. Anat., XXV. (1885) pp. 48–84 (1 pl.).

„ „ **Einiges über den Mitteldarm der Insecten sowie über Epithel-regeneration.** (On the mid-gut of insects and regeneration of epithelium.)
[Methods, *post*. Cf. *ante*, p. 231.]
Ibid., XXVI. (1885) pp. 229–306 (3 pls.).

FRIEDMANN, M.—**Ueber eine Modification der Weigert'schen Färbemethode für die markhaltigen Fasern der Centralorgane.** (On a modification of Weigert's staining method for the medullated nerve-fibres of the central organs.)
[Weigert's more recent copper method supersedes this.]
Neurol. Centralbl., 1885, p. 35.

G., R.—**Gum Tragacanth.**
[The best material for sticking labels to glass. As it will not dissolve in water like gum arabic, some find difficulty in preparing it. The best way is to select three or four white pieces, about the size of a coffee-berry, and place in a 2-oz. wide-mouthed bottle; then pour over it acetic acid so as to hardly cover the gum, and place the bottle aside until the next day, by which time the gum will have absorbed the fluid and become very much swollen. Now add water, stir well, and in a day or two a semi-transparent jelly will be the result. A drop or two of pure carbolic acid should be added, and it will then keep for any length of time without getting mouldy.]
Scientif. Enquirer, I. (1886) p. 46.

GAGE, S. H.—**The Limitations and Value of Histological Investigation.**
Proc. Amer. Assoc. Adv. Sci., XXXIV. (1885) pp. 345–9.

„ „ **Cutting sections of Cartilage.**
[Mainly directions for making sections freehand of the fresh material.]
Journ. New York Micr. Soc., II. (1886) p. 67,
from 'Notes on Histological Methods.'

GILES, G. W. M.—**On Marine Collecting with the Surface Net.**
[Notes on preserving (resinous media not suitable; use glycerin or glycerin jelly for all except shelled mollusca and worms). Cells. Making thin sections of Entomostraca and other minute Crustaceans. *Supra*, p. 701.]
Sci.-Gossip, 1886, pp. 121–3.

GILLO, R.—**On making useful Collections of Insects: A plea for the more general use of the Compound Microscope by Collectors.**
Journ. of Micr., V. (1886) pp. 168–78.

GRIFFITH, E. H.—**Turn-table improvement.** [*Supra*, p. 719.]
The Microscope, VI. (1886) p. 83.

„ „ **Slide Labels.** [*Supra*, p. 721.] *Ibid.*, p. 84.

GRUENHAGEN, A.—**Ueber ein Endothelial-Element der Nervenprimitivscheide.** (On an endothelial element of the primitive nerve-sheath.) [*Supra*, p. 700.]
Arch. f. Mikr. Anat., XXIII. (1884) pp. 380–1 (1 fig.).

HAMANN, O.—**Beiträge zur Histologie der Echinodermen. II. Die Asteriden.** (Contributions to the histology of the Echinodermata. II. The Asteridea.)
[Methods, *supra*, p. 702.] 126 pp., 7 pls. and 3 figs. (8vo, Jena, 1885).

HANSEN, E. C.—**Méthodes pour obtenir des cultures pures de Saccharomyces et de micro-organismes analogues.** (Methods for obtaining pure cultures of Saccharomyces and analogous micro-organisms.)
Medd. Carlsberg Laborat., II. (1886) Part 4.

HEIDENHAIN, R.—**Eine Abänderung der Färbung mit Hämatoxylin und chromsauren Salzen.** (A change of colour with hæmatoxylin and chromates.) [*Post.*]
Arch. f. Mikr. Anat., XXVII. (1886) pp. 383–4.

Hüppe, F.—**The Methods of Bacteriological Investigation**; written at the request of Dr. R. Koch; translated by *H. M. Biggs.* [*Supra*, p. 669.]
218 pp. (8vo, New York, 1886).

KALKOWSKY, E.—**Elemente der Lithologie.** (Elements of lithology.)
[Contains a description of methods of investigation.]
vii. and 316 pp. (8vo, Heidelberg, 1886).

Koch, R.—**Method of Staining Tubercle Bacilli.** Transl. by *R. Persh.* (*In part.*)
Micr. Bulletin (*Queen's*), III. (1886) pp. 22–3, from *M.T. K. Gesundheitsamte*, II.

L., V. A.—**Interesting Experiment for the Microscope.**
["The embryo grain of wheat, at the time of blossoming, being carefully taken out of the husk, will be found to have a small downy tuft at its extremity, which, when viewed in a Microscope, greatly resembles the branches of thorn, spreading archwise in opposite directions. By expanding a few of the grains and selecting the most perfect, a very pretty microscopic object will be obtained for preservation."
Scientif. Enquirer, I. (1886) pp. 87–8.

" " **Preparing Barbadoes Earth.** *Ibid.*, pp. 92–3.

LATHAM, V. A.—**The Microscope, and how to use it. VII.**
[Hardening agents.] *Journ. of Micr.*, V. (1886) pp. 179–84.

LETT, H. W.—**Mounting Fish Skins.**
[Too much pressure will make the scales smooth.] *Ibid.*, p. 91.

LINDT, O.—**Ueber den Nachweis von Phloroglucin.** (On the demonstration of phloroglucin.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, II. (1885) pp. 495–9.

MADDOX, R. L.—[**Preparing Bacteria.**] See Jennings, J. H., *supra*, p. 696.

MARTINOTTI, G.—**Berichtigung.** (Correction.) [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) p. 57.

MEYER, A.—**Microchemische Reaction zum Nachweis der reducirenden Zuckerarten.** (Microchemical reaction for demonstrating reducing sugars.) [*Post.*] *Ber. Deutsch. Botan. Gesellsch.*, III. (1885) p. 332.

MEYER, V.—**Trocken- und Erhitzungs-Apparate für das chemische Laboratorium.** (Drying and heating apparatus for the chemical laboratory.) [*Post.*]
Ber. Deutsch. Chem. Gesellsch., XVIII. (1885) p. 2999 (1 fig.).

MINOT, C. S.—**Structure of the Human Skin.**
[Contains a method of isolating the epidermis of human and other embryos from the underlying dermis. The method is also convenient for the study of the development of hairs. *Post.*]
Amer. Natural., XX. (1886) pp. 575–8 (2 figs.).

MOLL, J. W.—**Eene nieuwe microchemische looizuurreactie.** (A new microchemical reaction for tannin.) [*Post.*]
Maandblad voor Natuurwetensch., 1884.
Bot. Centralbl., XXIV. (1885) p. 250.

MÖLLER, J.—**Mikroskopie der Nahrungs- und Genussmittel aus dem Pflanzenreiche.** (Microscopy of the foods and drinks of the vegetable kingdom.)
394 pp. and 308 figs. (8vo, Berlin, 1886).

NISSEN, F.—**Ueber das Verhalten der Kerne in den Milchdrüsenzellen bei der Absonderung.** (On the relation of the nuclei of the milk-gland cells during secretion.) [Methods, *post.*]
Arch. f. Mikr. Anat., XXVI. (1886) pp. 337–42 (1 pl.).

ORTLEB, A. and G.—**Anleitung zur Mikroskopischen Untersuchungen** und Beobachtungen mit der Lupe von Kleinen Tierchen, wie Milben, Trichinen, Infusorien, Würmern, Insekten, &c., Pflänzchen und Mineralien. Nebst Anleitung zur Herstellung und Aufbewahrung der Präparate.
56 pp. and 3 pls., 8vo, Berlin, n.d.

Persh, R.—See *Koch, R.*

PISENTI.—**Di una modificazione alla formula del carminio alluminoso.** (On a modification of the formula for alum-carmine.) [*Post.*]
Gazzetta degli Ospitali, 1885, No. 24.

Potato, Rush, and Vegetable Ivory, Preparing.

[Partially desiccate, either by immersion in methylated spirit for a few days, or by exposure to the air. Sections may be readily obtained by imbedding and cutting in paraffin. Such sections mounted in balsam are very beautiful, the starch being seen *in situ*, whilst if polarized light be employed, each granule gives its characteristic black cross.

After prolonged soaking in cold water, may readily be cut in the microtome. The sections should be mounted unstained in balsam, and though not usually regarded as polariscopic objects, nevertheless, when examined with the selenite, yield very fine colours].

The Microscope, V. (1885) p. 215.

Pringsheim, N.—**Ueber die Sauerstoff-abgabe der Pflanzen im Mikrospectrum.** (On the excretion of oxygen by plants in the microspectrum.) [*Post.*]

Ber. Deutsch. Bot. Gesel., III. (1886) *Generalversamml.* pp. lxxii.–lxxx.

Rinnböck's Slides of arranged Diatoms.

[Physician has ordered him to do no microscopical work for a year, "but I fear that is for ever."]

The Microscope, VI. (1886) p. 134.

Rohrbeck, H.—**Trocken-apparat für Laboratorien mit Ventilation.** (Laboratory drying apparatus with ventilation.) [*Post.*] *Chem.-Ztg.*, 1885, No. 21.

Bot. Centralbl., XXVI. (1886) pp. 313–5.

Rollett, A.—**Untersuchungen über dem Bau der quergestreiften Muskelfasern.** (Researches on the structure of the striated muscle fibres.) II.

[Methods, *post.*]

Denkschr. Akad. Wiss. Wien, LI. (1885) 48 pp. and 4 pls.

Rouffart, E.—See Francotte, P.

Seguin.—**Anilinblauschwarz als Tinctionsmittel für Hirnschnitte.** (Anilin-blue-black as a staining medium for brain sections.)

Schweizer Correspondenzblatt, XIV. (1884) p. 45.

Selenka, E.—**Metallmodelle nach mikroskopischen Präparaten.** (Metal models of microscopical preparations.) *SB. Phys.-Med. Soc. Erlangen*, 1886, 3 pp.

Seymour's (M. L.) Injecting Apparatus.

[A column of mercury can be set at various heights in a slotted tube and delivers mercury to a jar partly filled with water, forcing the air into a second jar with the injecting solution. An Ashcroft pressure gauge is connected with the latter.]

St. Louis Med. and Surg. Journ., L. (1886) pp. 237–9 (1 fig.).

Sharp, B.—**Fermentation in Perenyi's Fluid.** [*Post.*]

Proc. Acad. Nat. Sci. Philad., 1886, p. 61.

Slack, H. J.—**Pleasant Hours with the Microscope.**

[Mouth-organs of Rotifers.] *Knowledge*, IX. (1886) pp. 246–7 (4 figs.).

Streng, A.—**Ueber eine neue Mikroskopisch-chemische Reaction auf Natrium.** (On a new micro-chemical reaction for sodium.)

Ber. Oberhess. Gesell. f. Natur- u. Heilk. Giessen, XXIV. (1885) pp. 56–8.

„ „ **Mikroskopisch-chemische Bestimmung von Kobalt und Nickel.** (Micro-chemical determination of cobalt and nickel.) *Ibid.*, pp. 56–8.

Vries, H. de.—**Over het algemeen voorkomen van circulatie en rotatie in de weefselcellen der planten.**

[Movements of protoplasm in tissue-cells.] [Methods, *supra*, p. 266.]

Maandbl. voor Natuurw., 1884. See *Bot. Centralbl.*, XXIV. (1885) p. 79.

W., E. W.—**Cement for Micro Work.**

["This cement I have found unfailing in micro work under a finishing varnish:—Gold size, 2 oz.; white lead, 1/2 oz.; red lead, 1/4 oz.; patent dryers, 1 dram. Grind the white lead, red lead, and dryers very fine, then add the gold size, which must be the very best and old."]

Scientif. Enquirer, I. (1886) p. 112.

Wagner, F. v.—**Das Nervensystem von Myzostoma.** (The nervous system of Myzostoma.) [Methods, *post.*] 52 pp., 1 pl. (8vo, Graz, 1886).

Wieger, G.—See Born, C.

PROCEEDINGS OF THE SOCIETY.

Meeting of 9th June, 1886, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The **Minutes** of the meeting of 12th May last were read and confirmed, and were signed by the President.

The **List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Hudson, C. T., and P. H. Gosse. The Rotifera; or Wheel Animalcules. Part IV., pp. 1–48, pls. 16–20. (8vo, London, 1886)	*The Publishers.*
Euler, L., Constructio Lentium Objectivarum ex duplici vitro. 31 pp. and 1 pl. (4to, Petropolis, 1762)	*Mr. Crisp.*
Fisher, G. T., Microscopic Manipulation. 72 pp. and 33 figs. (8vo, London, 1846)	,,
Gissler, C. F., Contributions to the Fauna of the New York Croton Water. 23 pp. and 5 pls. (8vo, New York, 1872)	,,
Hill, J., An History of Animals, containing descriptions of the Birds, Beasts, Fishes, and Insects, of the several parts of the world; and including accounts of the several classes of Animalcules visible only by the assistance of Microscopes. 584 pp. and 28 pls. (Fol, London, 1752)	,,
Optics. (Library of Useful Knowledge.) 68 pp. and 55 figs. (8vo, London, 1829)	,,
Optical Instruments. (Ditto.) 60 pp. and 89 figs. (8vo, London, 1832)	,,
West, T., On the Structure of the Seed in Solanaceæ. 7 pp. and 3 pls. (8vo, London, 1866)]	,,
26 Slides of various Starches	*Mr. Waldron Griffiths.*

Mr. G. F. Dowdeswell described a preparation of the microbe of rabies in the spinal cord of a rabid dog, which he exhibited under a Microscope in the room with 1/6 in. objective × 400 (*supra*, p. 669).

Mr. W. T. Suffolk called attention to twenty-six slides of various starches received from Mr. Waldron Griffiths, of Cirencester. The collection had been carefully made for trade verification purposes, and would be very useful in the determination of starches.

Mr. Crisp exhibited Beck's Mineral Microscope (*supra*, p. 673); also an electric incandescence lamp for the sub-stage, which he had received anonymously from America without the name of either designer or sender.

Prof. F. Jeffrey Bell exhibited a specimen received from Prof. MacIntosh, of St. Andrews, of a very young star-fish, in a stage so early as to show clearly the knob-like portions of the larval organ,

which he further illustrated by drawings on the board. Prof. MacIntosh had been giving some of his knowledge and skill to fishery observations, which had been rendered possible by the facilities afforded by an enlightened fishery board in Scotland. Some models deposited at the Natural History Museum at South Kensington (after Prof. Ludwig) were said to show these knobs admirably.

Mr. F. R. Cheshire exhibited a device for the better examination of bacteria in culture tubes. He said that it had been often complained that whilst bacteria were growing in glass tubes, the cylindrical form of the tube so distorted the appearance of the contents, that it was almost impossible to make any observations upon them under the Microscope. The difficulty had been felt by every one who wished to examine anything inside a glass tube, and, to endeavour to obviate it, the use of tubes with flat sides had been suggested. These to a certain extent answered the purpose, but they were expensive, and were also very troublesome in use, because the cotton plug could not be got to fit properly.

The contrivance he was about to mention was very simple, and was intended to enable any one to use the ordinary round test-tubes without being subject to the usual difficulties. The first plan adopted was that of placing the tube in a trough of water and then looking at it through the front of the trough. This was found to diminish the aberration very much, but it did not get rid of it altogether, and was therefore only available under very low powers. Water having a refractive index of about 1·333, and alcohol of about 1·374, by adding water to alcohol, a mixture having a refractive index of anything between the two could be obtained according to the proportions used. The gelatin culture material had a refractive index rather higher than that of water, and the interposition of the glass added something to this. The trough which he used for the purpose had been made under his directions by Mr. Curties, and had a front of rather thin glass, the bottom being sloped in such a way as to cause a tube placed in the trough to lie always near to the front. The tube to be examined was placed in the trough with some water, and then alcohol was added until the proper density was arrived at, and by this means it was quite possible to use a 1/2 in. objective effectively. It was, of course, desirable to have some ready method of testing the liquid, so as to ascertain when the best correction was reached. Perfect correction was of course impossible, as the centre of the cylinder would have a longer focus than the parts near the limb. The plan he adopted was to put opposite a source of light an upright rod, some two or three feet behind the tube, and then, when water was poured in, the rod would appear to be magnified; but by adding alcohol a point was reached where there was no magnification produced; this was the best point for use. A specimen of the trough charged with liquid and containing a tube ready for examination was handed round for inspection, and the construction of the base of the trough was further illustrated by a drawing on the board.

Mr. Groves thought the idea was very good; but it was not new, except perhaps in its application to the examination of test-tubes, In examining capillary tubes it had long been used, but glycerin was usually employed in place of alcohol.

Mr. Cheshire said he was not at first aware that glycerin had been used for the purpose, but he thought alcohol much better, as it mixed more freely with the water without producing any cloudy effect, and it dried off at once without any necessity for cleansing the tubes outside after using.

The President said they were always glad to have evidence of practical work brought before them, and no doubt the utility of this device would be readily apparent to all.

Prof. Bell, at the request of the President, gave an account of what he regarded as the most extraordinary biological fact brought to light during the last twenty-five years, that of a third eye at the top of the head of certain lizards (*supra*, p. 580).

The President said he was sure that all present must feel much obliged to Prof. Bell for the very clear manner in which he had described the features of this remarkable organ. For his own part he could only say that when he came to the meeting the facts were, so to speak, more or less in a cloud, but the lucid explanation of Prof. Bell had enabled him to see them in a clear light and to follow the conclusions to which they seemed to point.

Mr. Crisp called attention to a new lamp for the Microscope which had been sent for exhibition by Mr. Curties, and which was so cheap and simple that it seemed likely to become the lamp of the future. It was founded on the lamp originally devised by Mr. Nelson (*supra*, p. 688).

M. A. Brachet's communication suggesting the use of a hyperbolic lens for the field lens of the eye-piece was read. M. Brachet claimed that thereby the diaphragms in the eye-piece and objective could be dispensed with and the image much improved.

Dr. Crookshank read a paper on Photo-micrography, which was illustrated by the exhibition of a large number of prints, negatives, &c.

Mr. Glaisher said he had examined Dr. Crookshank's exhibits, and thought they were certainly very beautiful productions. He had for many years taken a great interest in the subject of photography, and had looked to it with hopes which had been more nearly fulfilled than ever before by the specimens before them. He had heard the paper with great pleasure, and could only express his admiration of it, believing as he did that it held out great promise for the future.

Mr. Dowdeswell said he quite agreed with what had been said as to the great value of photography for microscopical illustration, although he did not hold with Koch the opinion that it should supersede entirely all other methods; he thought rather that both drawing and photography should be employed for the purpose. The results shown by Dr. Crookshank in the room that evening were very beautiful and well worthy of examination by all who were interested in the subject.

The President said they were no doubt all agreed that the paper was a most valuable contribution to the important subject of photo-micrography, and it was certainly very encouraging to note the advances which were being made in the art as the process became more complete. For his own part he was very glad to have had the opportunity of seeing the results of such good work as Dr. Crookshank had produced before them that evening. The plates which he exhibited would bear much studying, and would impart a great deal of information to any one who gave attention to them.

Mr. F. Enock exhibited sketches of some of his slides, the various parts being numbered and named and accompanied by a short explanation. It is intended to issue sketches of all the mouth-organs of British bees, and other interesting insects (*supra*, p. 727).

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—Young Star-fish.

Mr. T. Bolton:—*Sphærosira volvox* and *Anuræa serrulata*.

Mr. Cheshire:—Device for the better examination of Bacteria in culture tubes.

Mr. Crisp: (1) Beck's Mineral Microscope; (2) Electric Incandescence Lamp for substage.

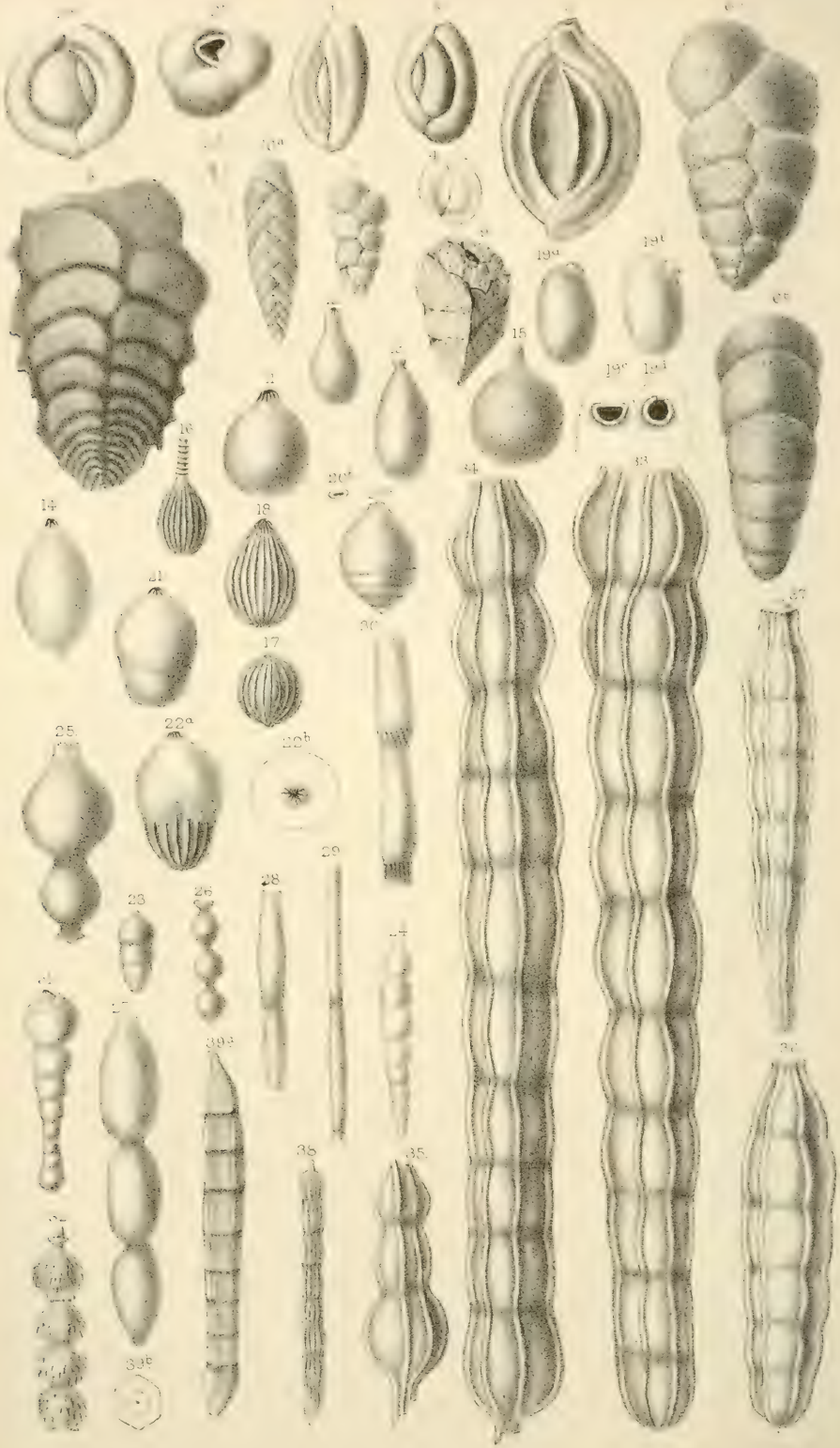
Dr. Crookshank:—Photo-micrographs illustrating his paper.

Mr. Curties:—New Lamp.

Mr. Dowdeswell:—Microbe of Rabies in the spinal cord of a rabid dog.

Mr. F. Enock:—Sketches of some of his slides.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. A. Durrand, J. Jerman, G. J. Lee, T. A. Mollet, R. W. Phillip, B.A., B.Sc., Prof. J. P. Remington, Ph.G., A. R. Stower, and C. J. Walker, B.A.



C.D Sherborn del.

West, Newman & Co. lith.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1886.

TRANSACTIONS OF THE SOCIETY.

XII.—*On some Microzoa from the London Clay exposed in the Drainage Works, Piccadilly, London,* 1885.

By Charles D. Sherborn and Frederick Chapman.

(*Read 13th October*, 1886.)

Plates XIV., XV., and XVI.

The excavation made in Piccadilly in 1885 gave us an opportunity of examining the London Clay there, and investigating its fossil microzoa. The specimens include both Foraminifera and Ostracoda, the latter being very rare. After a few preliminary words on the nature of the London Clay at this point, we will

EXPLANATION OF PLATES XIV., XV., XVI.

Plate XIV.

Fig. 1.—*Miliolina seminulum* (Linné), × 20. diams.
„ 2. „ *circularis* (Bornemann), × 20.
„ 3. „ *communis* (Deshayes), × 20.
„ 4. „ *secans* (d'Orbigny), × 20.
„ 5. „ *Ferussacii* (d'Orbigny), × 50.
„ 6*a*, *b*.—*Textularia agglutinans* d'Orbigny, × 50.
„ 7.—*Gaudryina pupoides* d'Orbigny, × 20.
„ 8.—*Bigenerina capreolus* (d'Orbigny), × 50.
„ 9.—*Verneuilina tricarinata* d'Orbigny, × 20.
Clavulina, see plate XV. fig. 1.
Bulimina, see plate XVI. fig. 1.
„ 10.—*Bolivina punctata* d'Orbigny × 50.
Cassidulina, see plate XVI. fig. 2*a*, *b*.
„ 11.—*Lagena globosa* (Montagu), × 50.
„ 12. „ „ „ var., × 20.
„ 13. „ *lævis* (Montagu), × 50.
„ 14. „ *apiculata* Reuss, × 20.
„ 15. „ *vulgaris* Williamson, v. *oxystoma* Reuss, × 50.
„ 16. „ *striata* (d'Orbigny), × 50.
„ 17. „ „ „ var., × 50.
„ 18. „ *sulcata* Walker and Jacob, × 50.
„ 19*a*-*d*. „ (*Obliquina*) *oviformis* n. sp. × 20.

proceed with a description of the Foraminifera, the Ostracoda having been handed over to Prof. Rupert Jones, who has expressed his wish to include them in his Supplement of the Tertiary Entomostraca to be published by the Palæontographical Society.

Commencing at Albert Gate, Knightsbridge, a series of shafts were sunk, which appear to have reached a depth of about 30 feet, passing through two "beds" of London Clay, an upper or brown,

Fig. 20*a*, *b*.—*Nodosaria* (*Glandulina*) *abbreviata* Neugeboren, × 20.
„ 21. „ „ *obtusissima* Reuss, × 50.
„ 22*a*, *b*. „ „ *semicostata* n. sp., × 50.
„ 23. „ *humilis* (Rœmer), × 20.
„ 24. „ *radicula* (Linné), × 20.
„ 25, 26. „ *soluta* (Reuss), × 20.
„ 27. „ *ovulata* n. sp., × 50.
„ 28, 29. „ *arundinea* Schwager, × 20.
„ 30. „ *subornata* Reuss, × 50.
„ 31. „ *clavata* Costa, × 50.
„ 32. „ *hispida* d'Orbigny, × 50.
„ 33. „ *affinis* d'Orbigny, × 20.
„ 34. „ *bacillum* Defrance, × 20.
„ 35. „ *badenensis* d'Orbigny, × 20.
„ 36. „ *raphanus* (Linné), × 20.
„ 37. „ „ „ var., × 20.
„ 38. „ *raphanistrum* (Linné) var., × 20.
„ 39*a*, *b*.—*Dentalina vertebralis* (Batsch), × 20.

Plate XV.

Fig. 1.—*Clavulina communis* d'Orbigny, × 20.
„ 2*a*, *b* ; 3*a*, *b* ; 4*a*, *b*.—*Nodosaria polygona*, Reuss, × 20.
„ 5. *Dentalina communis* d'Orbigny, × 20.
„ 6. „ „ „ var., × 20.
„ 7. „ *elegans* d'Orbigny, × 20.
„ 8. „ *inornata* d'Orbigny, × 20.
„ 9. „ *pauperata* d'Orbigny, × 50.
„ 10. „ *abnormis* Reuss, × 50.
„ 11*a*, *b*. } „ *adolphina* d'Orbigny, × 20.
„ 12. }
„ 13. „ *spinulosa* (Montagu), × 20.
„ *acicula* (Lam.) (woodcut), × 20.
„ 14. „ *multilineata* Bornemann, × 20.
„ 15. „ *obliquestriata* Reuss, × 20.
„ *vertebralis* (Batsch), see plate XIV. fig. 39*a*, *b*.
„ 16*a*, *b*.—*Rhabdogonium tricarinatum* (d'Orbigny) × 50.
„ 17.—*Marginulina bullata* Reuss, × 20.
„ 18. „ *Wetherellii* Jones, × 20.
„ 19*a*, *b*.—*Vaginulina legumen* (Linné), × 50.
„ 20*a*, *b*.—*Cristellaria obtorta* Terquem and Piette, × 50.
„ 21. „ *crepidula* (Fichtel and Moll), × 50.
„ 22*a*, *b*. „ *acutauricularis* (Fichtel and Moll), × 50.
„ 23*a*, *b*. „ *italica* (Defrance), see also plate XVI. fig. 4*a*, *b*), × 20.
„ 24*a*, *b*. } „ „ „ v. *spinulosa* nov., × 50.
„ 25*a*–*c*. }
„ *rotulata* (Lamarck) var., see plate XVI. fig. 3.
„ 26*a*, *b*. „ „ „ v. *flexuosa* nov., × 20.
„ 27*a*, *b*. „ *inornata* d'Orbigny, × 20.
„ 28*a*, *b*. „ *cultrata* (Montfort), × 20.
„ 29*a*, *b*. „ „ „ v. *splendens* nov., × 20.
„ 30. „ *megalopolitana* Reuss, × 20.

C.D. Sherborn del.

West, Newman & Co. lith.

C. D. Sherborn del.

West, Newman & Co. lith.

and a lower or black bed. We were unable to obtain any very definite information as to these strata, but from the foreman of the works we learned that, whilst at Albert Gate the "black bed" was almost at the surface, opposite Whitehorse Street, Piccadilly, where the last shaft was sunk, there was a considerable thickness of the "brown clay," with an occasional capping of gravel.

Respecting the "brown bed," Professor Prestwich has favoured us with the following note:—"It is probable that the brown clay belongs to a slightly higher bed, and it may be that the colour is due to the bed being slightly more porous, and to the percolation of the surface waters having oxidized the iron in it, producing the brown colour."* It may be well to mention that in washing we found both clays to be equally tenacious, and that there was some difference in the distribution of the fauna. Briefly here, and more particularly in the description of species, we note that in the brown or upper bed *Lagenæ* and *Planorbulinæ* were somewhat abundant and very delicate, whilst in the black clay these forms were very rare, the most abundant being *Pulvinulinæ* (*P. Boueana*, not found in the brown clay), *Nodosariæ*, *Dentalinæ*, and *Cristellariæ*; the *Lagenæ* being represented by thicker and more massive forms as *L. apiculata* and *L. oviformis*.

PLATE XVI.

Fig. 1.—*Bulimina affinis* d'Orbigny, × 50.
„ 2*a*, *b*.—*Cassidulina subglobosa* Brady, × 50.
„ 3.—*Cristellaria rotulata* (Lamarck) var., × 20.
„ 4*a*, *b*. „ *italica* Defrance, var., × 20.
„ 5.—*Polymorphina gibba* d'Orbigny, × 50.
„ 6. „ *gutta* d'Orbigny, × 50.
„ 7.—*Uvigerina asperula* Czjzek, × 50.
„ 8*a*, *b*.—*Globigerina bulloides* d'Orbigny, × 50.
„ 9.—*Orbulina universa* d'Orbigny, × 50.
„ 10*a*, *b*.—*Pullenia sphæroides* d'Orbigny, × 50.
„ 11*a*, *b*.—*Discorbina rosacea* d'Orbigny, × 20.
„ 12*a–c*.—*Truncatulina lobatula* Walker and Jacob, × 50.
„ 13*a–c*. „ *refulgens* (Montfort), × 50.
„ 14*a–c*.—*Planorbulina ammonoides* (Reuss), × 50.
„ 15*a–c*. „ *complanata* (Reuss) var., × 50.
„ „ *rotula* (d'Orbigny) (woodcut), 50.
„ 16*a–c*. „ *Ungeriana* (d'Orbigny), × 50.
„ 17*a*, *b*. „ *Haidingeri* (d'Orbigny) var., × 20.
Anomalina sp. (woodcut), × 20.
„ 18*a–c*.—*Pulvinulina repanda* (Fichtel and Moll), × 50.
„ 19*a–c*. „ „ „ „ v. *concamerata* Will., × 50.
„ 20*a–c*. „ *Boueana* (d'Orbigny), × 50.
„ 21*a–c*. „ *Karsteni* (Reuss), × 50.
„ 22*a–c*.
„ 23*a–c*. } „ *punctatula* (d'Orbigny) var., × 50.
„ 24.—*Tinoporus baculatus* Montfort, × 50.

[The specimens will be deposited in the British Museum.]

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* See also Prestwich, Quart. Journ. Geol. Soc., x. (1854) pp. 401–19.

Of the nature of the two clays, it will be enough to note that the residuum, after washing, of the brown clay was mainly small crystals of selenite, a little coarse subangular sand, and microzoa, the whole residuum being 2½ per cent. by weight of the amount washed. The clay, almost orange-brown when wet, was a dull red-brown when dry. Of the black clay (bluish-black, drying grey and showing when broken numerous sparkling points, the surfaces of quartz-grains and scales of mica) the residuum, 1¼ per cent. by weight of the sample taken, consisted of fine sand, mica, a little carbonaceous matter, and microzoa. No selenite was found in this black clay.

Traces of other organic remains were very scanty; the brown clay yielded one fish-scale; and the black clay some woody fragments, a small vertebra of a fish, a *Natica*, a *Nucula* (broken), fragments of echinoderm spines, and a specimen (crushed in on one side) of *Nautilus regalis*, containing in the adherent clay impressions and casts of *Ditrupa*, and with a *Vermicularia* encrusting a portion of the shell.

In the body of the paper the reader will notice in the description of a few species a note to the effect that they were also found at Chelsea. The exact locality was at the eastern foot of Stanley Railway Bridge, King's Road; and they were obtained from a sample of clay collected by Prof. Rupert Jones, merely as a test. We have noted their occurrence, but shall make no special point of it until we have systematically worked out the clay from this spot.

In writing this paper we have derived much advantage from Professor Rupert Jones' advice, and from the use of his books relating to the subject.

The Entomostraca.

Through the kindness of Professor Rupert Jones, we are enabled to give the following preliminary list of the Entomostraca. This we may reasonably regard as very interesting, when we take into consideration that the total number of valves did not exceed nineteen.

Cythere scrobiculoplicata Jones.
Cythere scabra v. Münst., new to Britain.
Cythere triangularis Reuss.
Cytheridea perforata (Roemer).
Cythereis Bowerbankiana Jones.
Cythereis sp. nov.
Cytherella compressa v. Münst.
Bairdia barbata ? (Sow.).
Macrocypris ? sp.

The Foraminifera.

The series of Foraminifera here to be described does not pretend to be a complete collection of all the forms known to occur in the London Clay, but it has added largely to those varieties already noted. At the end of the paper we give a complete list of all forms reported by authors to have been found in the London Clay, and it is our intention to collect further material for a more comprehensive study of this group. We have been favoured with an inspection of some of the forms collected by Messrs. Jones and Parker, from Copenhagen Fields, and have been kindly offered the loan of the Sheppey forms by Mr. Shrubsole; but we have decided to postpone our further examination of this facies, so many localities remaining as yet untouched.

In dealing with these forms we have kept in view the biological nature of the animal constructing the tests; and guided by the researches of Williamson, Carpenter, Parker, Jones, Brady, and others, our studies confirm the generally adopted opinion, that in many cases the most intimate links can be traced between apparently widely different forms, and that external sculpture, although of classificatory value, has not the same biological importance. The passage may be completely followed from a smooth shell through every degree of ornamentation, as dots, tubercles, and spines, whether scattered or arranged in longitudinal lines, into the most perfectly ribbed forms, either broken up or continuous, especially in the *Nodosarinæ*. Hence we quite agree in the opinion that, except in rare cases, the word "species" should stand "variety," and that many genera even become of doubtful value. We retain these binomial appellations merely for convenience. It was our intention, when first preparing this paper, to endeavour to group together under type-forms the principal figured individuals which from their slight variations have received specific names; but this has been done carefully by A. Goës in his paper "On the Reticularian Rhizopoda of the Caribbean Sea," * and it is unnecessary for us to repeat the attempt, more especially since his paper is printed in English. As a careful and painstaking endeavour to unravel the multitude of varietal forms elevated to the doubtful rank of "species," we gratefully acknowledge the assistance we have derived from this book and, though we do not agree with the author at all points, we strongly advise students of this difficult group of animals to give his book careful attention.

As the most convenient method of dealing with descriptions of

* Kongl. Svenska Vet.-Akad. Handl., x. (1882).

Foraminifera, we have followed H. B. Brady's classification as given in the 'Challenger' Monograph.*

Sub-kingdom Protozoa.
Class Rhizopoda.
Order Foraminifera—(Reticularia).
Family Miliolidæ.
Sub-family Miliolininæ.

Miliolina Williamson [1858].

Miliolina seminulum (Linné), plate XIV. fig. 1. *Serpula seminulum* Linné, 1767, Syst. Nat., 12th ed., p. 1264, No. 791; 1788, 13th (Gmelin's) ed., p. 3739, No. 2.—A poor specimen, having a peculiarly shaped outer chamber very similar to the figures in Plancus, 1739, De Conch. min. not., pl. ii. fig. 1, b, c. One specimen; black clay.

Miliolina circularis (Bornemann), plate XIV. fig. 2*a*, *b*. *Triloculina circularis* Bornemann, 1855, Zeitschr. deutsch. geol. Ges., Bd. vii. plate xix. fig. 4.—A rounded, almost spherical, triloculine form. Two specimens; black clay.

Miliolina communis (Deshayes), plate XIV. fig. 3. *Triloculina communis* Deshayes, 1831, Descrip. Coq. caract., plate iii. figs. 5–7. —Two specimens; black clay.

Miliolina secans (d'Orbigny), plate XIV. fig. 4. *Quinqueloculina secans* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 303, No. 43.—Small and poor. One example; black clay.

Miliolina Ferussacii (d'Orbigny), plate XIV. fig. 5. *Quinqueloculina Ferussacii* d'Orbigny, 1826, modèle, No. 32.—A *Quinqueloculina* with flattened edges, and with the chambers hollowed out along the centre, and like a furrow. This variety is well figured by Parker and Jones in Phil. Trans., 1865, plate xv. fig. 36, from the Arctic Seas. One example; brown clay.

Family Textularidæ.
Sub-family Textularinæ.

Textularia † Defrance [1824].

Textularia agglutinans d'Orbigny, plate XIV. fig. 6*a*, *b*. D'Orbigny, 1839, Foram. Cuba, p. 136, plate i. figs. 17, 18, 32, 34. —A well-developed, somewhat broad, but small example of this variety. One specimen; brown clay.

* Reports of the 'Challenger' Expedition, ix. (1884)—Report on the Foraminifera.

† See note on the Textulariæ of the London Clay by Jones and Parker, Ann. and Mag. Nat. Hist., xi. (1863) p. 96.

GAUDRYINA D'Orbigny [1840].

Gaudryina pupoides D'Orbigny, plate XIV. fig. 7. D'Orbigny, 1840, Mém. Soc. Géol. France, iv. p. 44, plate iv. figs. 22–4.—A small full-chambered variety of this typical form. Numerous; black clay.

BIGENERINA d'Orbigny [1826].

Bigenerina capreolus (d'Orbigny), plate XIV. fig. 8. *Vulvulina capreolus* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 264, No. 1, pl. xi. figs. 5, 6; modèles, No. 39.—This variety has been well figured by Brady in the 'Challenger' Monograph, plate xlv. figs. 1–4, and figs. 3 and 4 of these correspond very closely to our specimens. Unfortunately we have not met with a single individual with the continuous upper chamber, although this form is one of the most numerous in the collection. Very common, but small, in both clays (and at Chelsea).

VERNEUILINA d'Orbigny [1840].

Verneuilina tricarinata d'Orbigny, plate XIV. fig. 9. D'Orbigny, 1840, Mém. Soc. Géol. France, iv. p. 39, plate iv. figs. 3, 4.—A much worn example. Black clay.

CLAVULINA d'Orbigny [1826].

Clavulina communis d'Orbigny, plate XV. fig. 1. D'Orbigny, 1826, Ann. Sci. Nat., vii. p. 268, No. 4.—This sandy form is extremely common in our washings, but, with the single exception of the figure, only fragments occur.* One at least of our specimens has the triangular commencement mentioned by Brady as characteristic of *C. Parisiensis*. Abundant in both clays.

Sub-family BULIMININÆ.

BULIMINA d'Orbigny [1826].

Bulimina affinis d'Orbigny, plate XVI. fig. 1. D'Orbigny, 1839, Foram. Cuba, p. 109, plate ii. figs. 25, 26.—A very small but perfect example, corresponding with the one figured by Brady in the 'Challenger' Monograph, plate l. fig. 14. Brown clay.

BOLIVINA d'Orbigny [1839].

Bolivina punctata d'Orbigny, plate XIV. fig. 10*a*, *b*. D'Orbigny, 1843, Voy. Amér. Mérid., p. 63, plate viii. figs. 10–12.—A very small, rather flat and narrow form, minutely punctate all over; often bent or wavy in the line of growth. Abundant in both clays.

* See also op. cit., iv. (1859) p. 350, *Clavulina communis* (and "*Nodosaria rustica*" Jones).

Sub-family Cassidulininæ.

Cassidulina d'Orbigny [1826].

Cassidulina subglobosa Brady, plate XVI. fig. 2 *a*, *b*. Brady, 1881, Quart. Journ. Sci., n.s. xxi. p. 90. 'Challenger' Monograph, plate liv. fig. 17.—Our specimen, the first of this "genus" recorded from the London Clay, is very small, and we at first hesitated to place it under Brady's form, but remarking its pear-shaped bulimine-like orifice, and its subrotundate form, we consider it referable to this variety rather than to *C. crassa* d'Orbigny. One specimen; brown clay.

Family Lagenidæ.
Sub-family Lageninæ.

Lagena Walker & Boys [1784].

Lagena globosa (Montagu), plate XIV. fig. 11. *Vermiculum globosum* Montagu, 1803, Test. Brit., p. 524.—A single spherical chamber, sometimes inclining to oval, smooth, and shining, with an aperture of radiating fissures, stellate in appearance. We figure a typical specimen, but have also found the more oval varieties. Four or five examples; brown clay.

Lagena globosa (Montagu), var., plate XIV. fig. 12.—A dwarfed variety of *L. globosa*, in which the upper portion of the test is attenuated, forming a neck, at the apex of which is a stellate aperture. From the black clay.

Lagena lævis (Montagu), plate XIV. fig. 13. *Vermiculum lævis* Montagu, 1803, Test. Brit., p. 524.—Smooth, oval, passing into the shape of an oil-flask; the aperture is a lipped circular hole at the end of a longer or shorter neck. Three or four specimens; brown clay.

Lagena apiculata Reuss, plate XIV. fig. 14. *Oolina apiculata* Reuss, 1850, Haidinger's Nat. Abh., iv. p. 22, plate i. fig. 1.—Smooth, egg-shaped; narrowing to a blunt stellate aperture above, and having a short point below. Three specimens; black clay.

Lagena vulgaris Williamson; var. *oxystoma* Reuss, plate XIV. fig. 15. *Lagena oxystoma* Reuss, 1858, Zeitschr. d. g. Ges., x. p. 433; 1862, Sitz. K. Ak. Wiss. Wien, xlvi. p. 335, plate v. fig. 66.—A spherical form, with a neck rising abruptly from the chamber and ending in a circular orifice. The surface of this variety is granular, thus presenting a slight difference from *L. hispida* and *L. hystrix* Reuss ('Lagenideen').* This form was first noted by Reuss as a new species in 'Ueber die Foraminiferen von Pietzpuhl,' Zeitsch. d. Geol. Ges., x. (1858) p. 433, being figured by him subsequently in his 'Lagenideen,' quoted above. One; brown clay.

* SB. K. Akad. Wiss. Wien, xlvi. (1862) pl. vi. figs. 77–80.

Lagena striata (d'Orbigny), plate XIV. fig. 16. *Oolina striata* d'Orbigny, 1839, Voy. Amér. Mérid., p. 21, plate v. fig. 12.—This beautiful form has a somewhat egg-shaped chamber, delicately ribbed, and a long neck ornamented with very thin rings of shelly matter, at regular intervals. Our specimen differs from that figured in the 'Challenger' Monograph, plate lii. fig. 22, in that the neck-rings are oblique in that specimen, whilst in ours they are horizontal. One specimen; brown clay.

Lagena striata (d'Orbigny), var., plate XIV. fig. 17.—Most likely a variety of the last. D'Orbigny's original figure is round, with a flattened base, like an onion, and therefore this is more like the type. It has evidently lost its neck; and at the base there is a small projection. One specimen; brown clay.

Lagena sulcata Walker and Jacob, plate XIV. fig. 18. *Serpula* (*Lagena*) *striata, sulcata, subrotundata*, Walker and Jacob, 1784, Test. Min., p. 2, plate 1, fig. 6.—A coarsely ribbed ovate test. Unfortunately, only half of this specimen remains. It has split longitudinally, but its characters are so well marked as to make it easy of identification. One specimen; brown clay.

Lagena (*Obliquina* Seguenza) *oviformis* n. sp., plate XIV. fig. 19*a–d*.—Test thick, symmetrically oval, perfectly smooth, and glossy; orifice lateral, large, at the top of a short truncated cone, in the second sixth of the side. The aperture is round or semicircular. When round it has a notch in its upper lip reaching to the base of the cone. This form appears to be entirely new, the nearest to it being Seguenza's *Obliquina acuticosta*, figured in Terr. terz. Messina, 4to, Messina, 1862, p. 75, plate ii. figs. 65–67. We do not consider the lateral aperture of "generic" value, and therefore keep to *Lagena*. Amongst other figured *Lagenidæ* as approximating to this variety may be mentioned a broken and repaired specimen of *L. vulgaris* Will., figured by O. Rymer Jones, Trans. Linn. Soc., xxx., plate xix. fig. 2, and *Lagena apiculata* Reuss, Brady's 'Challenger' Monograph, plate lvi. fig. 4. In both of these the aperture is lateral. Gümbel's *L. perovalis*, figured in 'N. Alp. Eocängebirge,' Abh. K. Bayer. Ak. Wiss., 1866, Bd. x., plate i. fig. 7, is closely similar in outline. The little notch in the upper lip might have been regarded as of more value, were there not one specimen at least without it. Five specimens; black clay.

Sub-family Nodosarinæ.

Nodosaria Lamarck [1816].
(Glandulina d'Orbigny [1826].)

Nodosaria (*Glandulina*) *abbreviata* Neugeboren, plate XIV. fig. 20*a, b*. *Glandulina abbreviata* Neugeboren, Denkschr. k. Ak. Wiss. Wien, 1856, p. 68, plate i. fig. 1.—A short, round form,

with a truncated neck and slit-like aperture. In this last feature it approaches *Lingulina*. One specimen (figured) from the black clay; not rare in the brown clay, but smaller and perhaps immature.

Nodosaria (*Glandulina*) *obtusissima* Reuss, plate XIV. fig. 21. Sitz. k. Ak. Wiss. Wien, 1863, xlviii. p. 66, plate 8 fig. 92.—Smooth and round, consisting of two (or three) chambers, the upper much larger than the lower, and ending in a slightly conical stellate aperture. Four specimens; brown clay.

Nodosaria (*Glandulina*) *semicostata* n. sp., plate XIV. fig. 22*a*,*b*. —An apparently two-chambered, acorn-shaped form; the upper chamber is somewhat compressed and bilobed (slightly deformed?) on one side; the lower chamber is round, bluntly acute, with delicate longitudinal costæ. Mouth, a circle of radiating fissures, slightly produced. This specimen was, unfortunately, lost; but, careful drawings having been made from it, we are enabled to include it in our figures. One specimen; black clay.

Nodosaria humilis (Roemer), plate XIV. fig. 23. Roemer, 1841, Verst. Norddeutsch. Kreide, p. 95, plate xv. fig. 6.—A short 3- to 4-chambered, glanduline-like form, common in the Chalk. A good figure of this form is to be seen in Brady's 'Challenger' Monograph, plate lxi. fig. 28, under the name of *N. radicula*, of which indeed *humilis* is zoologically a variety. One specimen; black clay.

Nodosaria radicula (Linné), plate XIV. fig. 24. *Nautilus radicula* Linné, 1767, Syst. Nat., 12th ed., p. 1164, 285; 1788, ibid., 13th (Gmelin's) ed., i. p. 3373, plate vi., No. 18.—A uniform or gradually increasing series of smooth chambers, spherical in section. Rare and poor; only found in the black clay.

Nodosaria soluta (Reuss), plate XIV. figs. 25, 26. *Dentalina soluta* Reuss, 1851, Zeitschr. d. geol. Ges., iii. p. 60, plate iii. fig. 4.—Of our two figured examples, one (26) approximates very closely to Reuss' original figure, and the other is comparable with the variety figured by Von Hantken in Mitth. k. ung. geol. Anst., 1875, iv., plate iii. fig. 2. In Reuss' figure we find the chambers to be apparently all of one size; in Von Hantken's figure, on the other hand, we are shown a series of four chambers, the last of which is three times larger than the first. Our specimen of this form has unfortunately only two chambers, and part of a third, but otherwise the resemblance to Von Hantken's figure is perfect. In 1865 Reuss figured in his 'Kreide Kanara-See' (Sitz. k. Ak. Wiss., lii. plate i. fig. 4), a form which he names *N. prægnans*; and as this is almost the same as that figured by Von Hantken as *N. soluta* Reuss, we presume Von Hantken did not see Reuss's figure. Biologically we draw no distinction between any of these forms, and are quite content to let the specimen under notice

remain as *N. soluta* Reuss, as figured by Von Hantken. In the British Museum (Natural History), tablet "49,531, London Clay, Haverstock Hill, London," are two large and single chambers, exactly like the last chamber of our figure. They are marked "*N. soluta*? Reuss," by Prof. Rupert Jones,* and we had no doubt on seeing them, that they were upper portions of the same form that we figure, having rapidly increasing chambers. Of Reuss' original type, one specimen only; black clay. Of Von Hantken's variety, the figured specimen, from the black clay and a few single chambers from the brown.

Nodosaria ovulata n. sp., plate XIV. fig. 27.—A series of sub-cylindrical, egg-shaped chambers, separated from each other by a short neck. This is the only specimen found in which there is a series of chambers; but as there are many single chambers in the brown clay, we consider it a permanent variety. Brown clay.

Nodosaria arundinea Schwager, plate XIV. figs. 28, 29. Schwager, 1866, 'Novara' Exped., Geol. Theil, Bd. ii. p. 211, plate v. figs. 43–5.—This long narrow *Nodosaria* has been considered by former authors to be the same as *N. longiscata* of d'Orbigny (Foram. Tert. Vienne, 1846, plate i. figs. 10–11); but on a careful examination of his figure, we find that the chambers end basally in an angular manner, the apices of the next below joining them in the centre, so that the shell presents, as it were, the appearance of a pile of narrow sugarloaves. In the table attached to Jones and Parker's 'Foram. London Clay' ('Geologist,' vii. 1864, p. 88), we note *longiscata* bracketed with *ovicula* d'Orbigny, as occurring at Copenhagen Fields. Having examined some of the original specimens in Prof. Rupert Jones' collection, we find that they are like the forms under notice, and we are more confirmed in the view that we are not dealing with d'Orbigny's *longiscata*. In Schwager's figures the precise form of our shells is given; those with the swollen centres being much rarer than those uniformly parallel-sided. All our examples are in a fragmentary state; we have not met with any specimens of more than two chambers. Mr. Shrubsole in his paper on 'The New Town-Well at Sheerness,' Proc. Geol. Assoc. v. (1876–8) p. 360, quotes *N. longisecta* as occurring; but we have treated this as a misprint for *longiscata*. Rare; in both clays; one fragment also from Chelsea.

Nodosaria subornata Reuss, plate XIV. fig. 30. Reuss, 1865, Sitz. k. Ak. Wiss. Wien, lii. p. 459, plate i. figs. 9–10.—A smooth *Nodosaria*, ornamented with short riblets crossing the septa. Under this name Reuss also figures one specimen ribbed continuously from end to end; but others, and ours, have fine ribs only at the junction of the chambers. In our specimen these are a little oblique; and from the fragment left to us we gather that the chambers were drop-shaped,

* Catal. Foss. Foram. Brit. Mus., 1882, p. 20.

longer, and not so uniform as in the specimen figured by Reuss. As striking examples of the close relationship of the many forms, slightly varying, as well in their Dentaline and Nodosarian shapes, as in their intermittent markings, we may refer to Reuss, Z. d. g. G., iii. (1851) plate iii., *D. Philippi* Rss., fig. 5, *D. Buchii* Rss., fig. 6, *D. obliquestriata* Rss., fig. 11; also to Reuss, Sitz. k. Ak. Wiss. Wien, xviii. (1855), plate i., *N. cylindrella* Rss., fig. 2, *D. capitata* Boll, fig. 4, *D. Sandbergeri* Rss., fig. 5, *D. Girardana* Rss., fig. 6, *D. intermittens* Bronn, fig. 7, and others. (See lists in Goës's excellent memoir, 1882, K. Sv. Vet.-Akad. Handl., Bd. xix.) From the brown clay.

Nodosaria clavata Costa, plate XIV. fig. 31. *Vaginulina clavata* Costa, 1855, Mem. Accad. Sci. Napoli, plate iii. fig. 18, A and B. This variety seems referable to Costa's figure A; our specimen and his figures are undoubtedly *Nodosariæ*, and, we are disposed to think, monstrosities. One only, black clay.

Nodosaria hispida d'Orbigny, plate XIV. fig. 32. D'Orbigny, 1846, Foram. Tert. Vienne, p. 35, plate i. fig. 24. A short, stout, and thickly spinous *Nodosaria*. Two specimens; black clay.

Nodosaria affinis d'Orbigny, plate XIV. fig. 33. D'Orbigny, 1846, Foram. Tert. Vienne, p. 39, plate i. fig. 36.—A very large and perfect individual, having all the characteristics of d'Orbigny's figure, with the exception of the basal spike. In its place our specimen has a circular orifice, probably due to fracture. Along the last few chambers the ribs have a tendency to take a spiral direction; and this in one individual (a passage-form to *N. badenesis* d'O.) persists to such an extent that a definite twist has occurred, and the last chamber is turned once round on the next below, the ribs being confusedly coiled together at the constriction. From the black clay; fragments numerous in both beds.

Nodosaria bacillum Defrance, plate XIV. fig. 34. Defrance, 1825, Dict. Sci. Nat., xxxv. p. 127, xxxvi. p. 487; Atlas Conch., plate xiii. fig. 4; Blainville, Malacologie, plate v. fig. 4.—Large and fine, differing very slightly from the last variety; it is bulbous at the lower end and not so distinctly constricted in the first three-quarters of the shell. Black clay; fragments numerous in both beds; found also at Chelsea.

Nodosaria badenensis d'Orbigny, plate XIV. fig. 35. D'Orbigny, 1846, Foram. Tert. Vienne, p. 38, plate i. fig. 34.—A short stunted variety of the last, differing from it chiefly in the chambers rapidly decreasing in size. Sowerby, in Wetherell's paper on the 'Hampstead Well,' Geol. Trans., ser. 2, v. plate ix. fig. 8, figures a typical London Clay example. Rare, but occurring in both clays. The figured specimen is from the brown clay.

Nodosaria raphanus (Linné), plate XIV. fig. 36. *Nautilus raphanus* Linné, 1767, Syst. Nat., 12th ed., p. 1164, No. 283; 1783, ibid., 13th (Gmelin's) ed., p. 3372, No. 16.—A very characteristic specimen of this type form. Sowerby figures a similar example from the Hampstead well in Wetherell's paper (op. cit.). One specimen; black clay.

Nodosaria raphanus (Linné) var., plate XIV. fig. 37.—An elongated variety of the last mentioned. One specimen; black clay.

Nodosaria raphanistrum (Linné), plate XIV. fig. 38. *Nautilus raphanistrum* Linné, 1767, Syst. Nat., 12th ed., p. 1163, No. 282.—Poor, thin and irregular, broken at lower end. H. B. Brady in 'Somerset Proceedings, &c.,' 1865–6, plate i. fig. 7, figures *N. raphanistrum* from the Lias, and this much resembles our specimen. One of Reuss' figures of *N. subornata* (Sitz. k. Ak. Wiss. Wien, lii. 1865, plate i. fig. 10) comes close to this form, and *Dentalina nodosa* d'O., as figured by Vanden Broeck in Ann. Soc. Belge Micr., ii. 1876, plate ii. fig. 10, represents the curved and tapering variety, *D. acicula* (Lam.). Parker and Jones (1859, A. M. N. H., ser. 3, iii. p. 478) state that "Mr. Hanley has satisfactorily determined the *Nodosaria* denominated *raphanistrum* by Linnæus, and has figured it in the Ipsa Linn. Conch., plate v. fig. 4. This proves to be the *Nodosaria bacillum* of Defrance (Dict. Sci. Nat.) and the *N. æqualis* of Sowerby ('Genera' and 'Manual'). It was published in the 10th edition of the Syst. Nat. without any reference to a figure; but in the 12th edition Linné referred to Ledermüller's plate iv. fig. *æ.* posterior, as the best published representation. This, though a dwarfish form, serves to link *N. raphanus* with *N. raphanistrum.*" These remarks are illustrated by our figures in plate XIV., where the gradations between the several varieties of this interesting *Nosodaria* can be readily recognized. Fig. 38 is equivalent to one of Ledermüller examples, though longer and more slender; and Ledermüller's other figure, quoted by Linné, is thicker and more like the common *N. raphanus.* One specimen; black clay.

Nodosaria polygona Reuss, plate XV. figs. 2*a*, *b*; 3*a*, *b*; 4*a*, *b*. Reuss, 1855, Z. d. geol. Ges., vii. p. 266, plate viii. fig. 7.—A many-chambered form, commencing with a swollen chamber and growing upwards regularly and increasingly for some distance, then assuming the characters of *N. bacillum* Defrance or *N. raphanus* (Linné). In transverse section in the lower part of the shell we see eight sharply angular ribs. Reuss' figure exhibits the peculiarities of the form perfectly, and in his description he has fully recognized its affinities to *N. bacillum* Defr. and *N. affinis* d'Orb. We figure a specimen of the early chambers (fig. 4), and one (fig. 3) showing the relation of the shell to *N. raphanus.* Five imperfect specimens, Stanley Railway Bridge, Chelsea.

Dentalina communis d'Orbigny, plate XV. fig. 5. D'Orbigny, 1826, Ann. Sci. Nat., vii. p. 254, No. 55; Jones, Parker, and Brady, Crag Foram. Pal. Soc., 1866, p. 58.—This rather fine individual, with straight septa, appears to have been still larger, as the last perfect chamber shows the broken base of another. It is smooth and translucent. One specimen and fragments; black clay.

Dentalina communis d'Orbigny, var., plate XV. fig. 6.—Much smaller than the last, but almost identical in other characters. Our figure is from the black clay, but it occurs, though rarely, in both clays; also at Chelsea.

Dentalina elegans d'Orbigny, plate XV. fig. 7. D'Orbigny, 1846, Foram. Tert. Vienne, p. 45, plate i. figs. 52–6.—An extremely delicate variety, and even neater than d'Orbigny's figure. One specimen; black clay.

Dentalina inornata d'Orbigny, plate XV. fig. 8. D'Orbigny, 1846, Foram. Tert. Vienne, p. 441, plate i. fig. 50.—The three last chambers of a *Dentalina* very near to d'Orbigny's figure. From the black clay.

Dentalina pauperata d'Orbigny, plate XV. fig. 9. D'Orbigny, 1846, Foram. Tert. Vienne, p. 46, plate i. figs. 57–8.—Characterized by its squat appearance, chambers square-shaped in side view, and regularly even in growth. Two specimens; from the brown clay.

Dentalina abnormis Reuss, plate XV. fig. 10.—Reuss, 1863, Sitz. k. Ak. Wiss. Wien, xlviii. p. 46, plate ii. fig. 24.—A three-chambered form, found by Reuss in the "Septarienthon" of Offenbach. Black clay.

Dentalina adolphina d'Orbigny, plate XV. fig. 11*a*, *b*; 12. D'Orbigny, 1846, Foram. Tert. Vienne, p. 51, plate ii. fig. 18.—This elegant and very common variety appears at first sight to be smooth; but under the Microscope it shows bases of delicate spines. These are uniformly distributed over the last chambers, but very regularly in two rows around the basal half of each of the other chambers. As these shells have been found by us straight instead of curved, and so becoming very much like the simpler forms, this arrangement of spines helps to fix the variety. A delicate spine, sometimes forked, usually commences the first chamber, and is generally placed on the concave side of the shell. Fig. 11*b* is a perfect mouth from another individual. Fig. 12 is a perfect, but feebly grown specimen. Very common in the black, rare in the brown clay.

Dentalina spinulosa (Montagu), plate XV. fig. 13. *Nautilus spinulosus* Montagu, 1808, Test. Brit. Suppl., p. 86, plate xix. fig. 5. Our specimens are like that figured by Sowerby in Wetherell's paper on the 'Hampstead Well' (op. cit.).—An extremely variable form in its markings, which pass from true

spines to triangular points (as in Sowerby's figure, which is a typical condition), from points to winged terminal riblets at the bases of the chambers, and further to riblets often continuous along the first-formed portions of the shell. The same gradations are shown, though less perfectly (on account of the paucity of individuals) on tablet 49,491, in the British Museum (Nat. Hist.). This series came from the London Clay of Haverstock Hill, London. Montagu's original figure appears to represent some of the middle chambers of a *D. adolphina* d'Orb. A reference to our figure of this variety (fig. 11*a*) will show that the uppermost chambers become elongate sometimes and fully spinose as in some chambers of *D. spinulosa*. Very common in both clays, generally fragmentary; also at Chelsea.

Fig. 154.

Dentalina acicula (Lamarck). Woodcut, fig. 154. *Orthocera acicula* Lamarck, 1822, Hist. Anim. sans Vert., vii. p. 594, No. 5.—Here are some lower chambers of an individual belonging to this variety. There is a similar fragment in the British Museum, tablet 49,490) from the London Clay, Islington, London), which shows the same continuous costæ. In both cases the upper part has disappeared. This form commences from a point and increases gradually in size.

Lamarck says it is straight (*Nodosaria*), but the difference between *Nodosaria* and *Dentalina* being merely one of curvature, we refer it to this latter form, taking as our type the specimen quoted above, from the British Museum, and included in Prof. Rupert Jones' Catalogue, p. 20. Black clay.

Dentalina multilineata Bornemann, plate XV. fig. 14. Bornemann, 1855, Zeitschr. d. geol. Ges., vii. p. 325, plate xiii. fig. 12.—A curved, horizontally chambered, and finely ribbed form, of which, unfortunately, the top is missing. Although Bornemann's figure only gives us three chambers, still, considering its fine ribbing and the position of chambers, we consider our form to be the same. In 1874 Reuss figured in Geinitz's 'Elbthalgebirge,' 4to, Cassel, 1872–4, plate xx. fig. 13, the upper end of a *Dentalina*, the same as that of Bornemann, calling it a new species and using the same name as Bornemann did twenty years before. Two fragments; black clay.

Dentalina obliquestriata Reuss, plate XV. fig. 15. Reuss, 1851, Zeitschr. d. geol. Ges., iii. p. 63, plate iii. figs. 12, 13.—Under this name Reuss figures in his 'Septarienthon,' two lower ends of a Dentaline form, with fine oblique striæ. Batsch, in 1791, figured a form very similar, but with fewer, coarser, and more continuous costæ; and this he called *Nautilus obliquatus*. Our specimen consists of five chambers, and both ends appear to have been broken away. One specimen; black clay.

Dentalina vertebralis Batsch, plate XIV. fig. 39*a*, *b*. *Nautilus* (*Orthoceras*) *vertebralis* Batsch, 1791, Conchyl. Seesandes, p. 3, No. 6, plate ii. figs. 6 *a* and *b*.—Six-sided, with horizontal chambers. Our figure is narrower and longer than that figured in 'Challenger' Report, plate lxiii. fig. 35. This and a fragment from the black clay.

Rhabdogonium Reuss [1860].

Rhabdogonium tricarinatum (d'Orbigny), plate XV. fig. 16*a*, *b*. *Vaginulina tricarinata* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 258, No. 4; modèle No. 4.—A many chambered Nodosarine; the chambers triangular. Balkwill and Wright in Trans. R. I. Acad., 1885, xxviii., plate xii. figs. 17, 18, figure a recent specimen of this variety. In their figure we are only shown a two-chambered form, whilst d'Orbigny's original has many chambers. Our example agrees with Balkwill and Wright's figure in having two chambers; but the lower chamber in our specimen is rotundate and not ribbed at the angles; moreover there is a marked swelling on two sides, and one of the ribs is double. The mouth also differs; in ours it is stellate,* in theirs it is triangular. These differences, however, we do not consider sufficient to allow us to form a new variety. One specimen; brown clay.

Marginulina d'Orbigny [1826].

Marginulina bullata Reuss, plate XV. fig. 17. Reuss, 1845–6, Verst. böhm. Kreide, part i. p. 29, plate xiii. figs. 34–8.—A dwarfed and much curved *Marginulina glabra* d'O. One specimen; black clay.

Marginulina Wetherellii Jones, plate XV. fig. 18. Jones, 1854, Morris' Cat. Brit. Foss., 2nd edition, p. 37.—This common and beautiful form shows great variety of sculpture—indeed, so much so, that amongst no more than one hundred individuals we are able to pick out nine or ten different ornamentations. Some of these are smooth, with a transverse rib or limbate thickening at the junction of each chamber; others are like the last, but with scattered tubercles on the chambers; others with tubercles closely packed on the coiled part of the shell, the upper part having plain limbate sutures or transverse ribs; a fourth variety, in which the transverse ribs alternate with bands of tubercles; a fifth has the ribs themselves broken up into tubercles and irregular bosses, the body of the chambers remaining smooth; a sixth is tuberculate but with no sutural ribs; a seventh has the sutural tubercles elongate, and so gradually forming longitudinal ribs; and lastly, there are specimens like our figure, which has its early chambers longitudinally

* See also Karrer, SB. K. Akad. Wiss. Wien, xliv. (1861) pl. i. fig. 5.

ribbed, and its upper chambers decorated with minute prickles and burs. In transverse section all specimens vary from nearly circular to a long oval; and many of them have a more or less serrated keel. Remarking all these differences, we cannot refrain from calling the student's attention to the undermentioned figures as a few of the forms shown under different names. All these we prefer to regard as belonging to this variety, for we can closely match them amongst the specimens collected by us from the Piccadilly clay.

Cristellaria decorata Reuss, Z. d. geol. Ges., 1855, vii. plate viii. fig. 10; plate ix. fig. 2. *Marginulina fragraria; M.* (*Crist.*) *asperula*, *C. cumulicostata* Gümbel, Abh. k. Ak. Wiss. Wien, 1868, x. plate i. figs. 58, 65, 67. *C. arcuata* Phil.; *C. gladius* Phil.; *C. fragraria* Gümb., Von Hantken, Mitth. k. ung. geol. Anst., 1875, iv. plate v. figs. 10 and 12; plate vi. figs. 1, 2, and 3.—Sowerby, in Wetherell's paper (op. cit., fig. 12), figures this variety; and an elongate specimen occurs in plate cxiv. fig. 14 of Brady's 'Challenger' Monograph. Although it was mentioned in Morris's Catalogue as above quoted, its relation to other forms was first described by Parker and Jones, 1859, Ann. and Mag. Nat. Hist., ser. 3, iv. p. 350. This is very common in both clays at Piccadilly, and also occurs at Chelsea.

Vaginulina d'Orbigny [1826].

Vaginulina legumen (Linné) var., plate XV. fig. 19*a*, *b*. *Nautilus legumen* Linné, Syst. Nat., 12th ed., p. 1164, fig. 288. Test smooth, much compressed, of six rapidly increasing chambers. One specimen; brown clay.

Cristellaria Lamarck [1816].

Cristellaria obtorta Terquem and Piette, plate XV. fig. 20*a*. *b*. Terquem, 1860–1, Mém. Acad. Imp. Metz. xlii. Ann. p. 459, plate vi. fig. 20.—A very rare form of *Cristellaria*, nearly straight, recorded by Terquem from the Lias of the Department Moselle. The figure referred to has more chambers than ours, and does not show any trace of the spiral; but we do not consider it necessary to divide them. One specimen; brown clay.

Cristellaria crepidula (Fichtel and Moll), plate XV. fig. 21. *Nautilus crepidula* Fichtel and Moll, 1803, Test. Microsc., p. 107, plate xix. figs. *g–i*. — An elongate, erect, and compressed form, eminently characteristic of Jurassic deposits, and subject to great variety. One specimen; brown clay.

Cristellaria acutauricularis (Fichtel and Moll), plate XV. fig. 22*a*, *b*. *Nautilus acutauricularis* Fichtel and Moll, 1803, Test. Microsc., p. 102, plate xviii. figs. *g–i*.—A small, smooth form, well figured in Brady's 'Challenger' Monograph, plate cxiv. fig. 17. One specimen; brown clay.

Cristellaria italica (Defrance), plate XV. fig. 23*a*, *b*, XVI. 4*a*, *b*.—*Saracenaria italica* Defrance, 1824, Dict. Sci. Nat., xxxii. p. 177 ; xlvii. p. 314 ; Atlas Conchyl., plate xiii. fig. 6.—Elongate, erect, and triangular, with chambers which rapidly widen. Fig. 4, plate XVI. is a variety of this form. Brown clay.

Cristellaria italica (Defrance) var. *spinulosa* nov., plate XV. fig. 24*a*, *b* ; 25*a*–*c*.—In 1863, Reuss figured in his 'Foram. Septarien-Thones Offenbach,' Sitz. k. Ak. Wiss. Wien, xlviii. pp. 49–53, plate iv. figs. 44–9, 51–4, and plate v. figs. 60 and 61, several varieties of *Cristellariæ*, all referable to *C. italica*. Three of these (51, 52, 60) are very closely similar to our specimens, the difference being chiefly in the ornamentation ; and on this account we propose to call them var. *spinulosa*. Similar unornamented figures occur in Von Schlicht, 'Foram. Septarienthones Pietzpuhl,' 4to, Berlin, 1870, plate XIII. figs. 19, 20, 23, 24, 25. One of our figures shows a two-chambered form, the other a 4- or 5-chambered, the first two being indistinct ; both are more or less covered with short spines, and the larger of the two is limbate between its chambers. The two figured specimens are all that are known ; from the brown clay.

Cristellaria rotulata (Lamarck) var., plate XVI. fig. 3. *Lenticulites rotulata* Lamarck, 1804, Ann. du Muséum, v. p. 188, No. 3 ; Tableau Encycl. et Méth., plate cccclxvi. fig. 5.—A poor and starved example. The true and well-developed form can be seen in many papers, especially in Vanden Broeck's memoir, Ann. Soc. Belge Microsc., ii. 1876, plate iii. fig. 1. Black clay, Piccadilly ; also at Chelsea.

Cristellaria rotulata (Lamarck) var. *flexuosa* nov., plate XV. fig. 26*a*, *b*.—We have not previously met with this form. It appears to be a variety of *C. rotulata*, and may be described as follows :—A wax-like test, greenish-grey in colour, with the central boss much whiter than the rest of the shell. Keel obsolete or almost absent, merely defined by tint ; no external trace of septation, the whole surface being uniformly smooth. Strongly waved or flexed in the line of growth, giving the shell a contorted appearance. One specimen ; black clay.

Cristellaria inornata d'Orbigny, plate XV. fig. 27*a*, *b*. *Robulina inornata* d'Orbigny, 1846, For. Tert. Vienne, p. 102, plate iv. figs. 25, 26.—Smooth, the septal planes showing through the shell as darker lines. Rare ; from the black clay.

Cristellaria cultrata (Montfort), plate XV. fig. 28*a*, *b*. *Robulus cultratus* Montfort, 1808, Conchyl. Syst., i. p. 214, 54^{e} genre.—A very common but distinct form, being keeled. The central boss passes from circular to polygonal, as shown in our figure. This is a rather fine example compared with the others from our washings, and there is apparently a chamber missing, which we have

indicated by a dotted line. *C. cultrata* has often been well figured, especially by Vanden Broeck, Ann. Soc. Belge Micros., 1876, ii. plate iii. fig. 3, and by Terrigi, Atti Accad. Pont. N. Lincei, 1880, anno xxxiii. pl i. fig. 12. Black clay; rare in the brown; also at Chelsea.

Cristellaria cultrata (Montfort), var. *splendens* nov., plate XV. fig. 29*a*, *b*.—More compressed than the type; no central boss; septa limbate, ten visible, neat and symmetrical; a large and showy specimen. One example; from the black clay.

Cristellaria megalopolitana Reuss, plate XV. fig. 30*a*, *b*. Reuss, 1855, Zeitschr d. geol. Ges., Bd. vii. p. 267, plate ix. fig. 5.—In 1860, Bornemann figured in Z. d. geol. Ges., Bd. xii. plate vi. fig. 2, *Robulina magdeburgica* (= *Nonionina magdeburgica* Philippi), a form with spreading septal ribs, similar in every respect to Reuss's *megalopolitana*. On reference to Philippi's original figure ('Palæontographica,' 1846–51, Bd. i. Tab. x^a. fig. 21), we find the septal ribs of his form to be regular and parallel-sided, and not tapering, hence we consider that Bornemann's figure cannot be accepted as the form intended by Philippi, but must be referred to Reuss's figure. The classificatory value of varying external ornament must be accepted as of some importance in these minor divisions. We therefore prefer to use Reuss's name, which has priority over Bornemann's. One specimen; black clay.

Sub-family Polymorphininæ.

Polymorphina d'Orbigny [1826].

Polymorphina gibba d'Orbigny, plate XVI. fig. 5. *Polymorphina* (*globulina*) *gibba* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 266 No. 20, modèle, No. 63.—Subrotundate, septal lines merely traced upon the surface. In our specimen the aperture is a little on one side. Only one specimen; black clay.

Polymorphina gutta d'Orbigny, plate XVI. fig. 6. *P.* (*Pyrula*) *gutta* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 267, No. 28, plate xii. fig. 5–6, modèle, No. 30.—Amongst the forms obtained occurs a shell which has been broken in half in its whole length, exposing the arrangement of the interior. We have no hesitation in recording it as above, but unfortunately can only figure it in outline. Brown clay.

Uvigerina d'Orbigny [1826].

Uvigerina asperula Czjzek, plate XVI. fig. 7. Czjzek, 1848, Haidinger's Nat. Abh., ii. p. 146, plate xiii. fig. 14.—The prickles on this form appear to be minute sharply pointed granules, very closely packed together. Very abundant in both clays.

Family Globigerinidæ.

Globigerina d'Orbigny [1826].

Globigerina bulloides d'Orbigny, plate XVI. fig. 8*a*, *b*. D'Orbigny, 1826, Ann. Sci. Nat., vii. p. 277, No. 1; modèles, Nos. 71 and 76.—Small but very perfect specimens. Abundant in the brown clay; not so common in the black.

Orbulina d'Orbigny [1839].

Orbulina universa d'Orbigny, plate XVI. fig. 9. D'Orbigny, 1839, Foram. Cuba, p. 3, plate i. fig. 1.—Of this interesting form we have only found one individual. It has been recorded from Sheppey by Mr. Shrubsole. It is not unlikely that, from its minute size, this is frequently overlooked. Brown clay.

Pullenia Parker and Jones [1862].

Pullenia sphæroides (d'Orbigny), plate XVI. fig. 10*a*, *b*. *Nonionina sphæroides* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 293, No. 1.; modèle, No. 43.—Only this single specimen met with; black clay.

Family Rotalidæ.
Sub-family Rotalinæ.

Discorbina Parker and Jones [1862].

Discorbina rosacea (d'Orbigny), plate XVI. fig. 11*a*, *b*. *Rotalia rosacea* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 273, No. 15; modèle, No. 39.—Not uncommon in our washings, and with the radiate limbation very distinct. Our specimens correspond closely with Williamson's figure in 'Recent Foram. Great Britain,' Ray Society, 1858, plate iv. figs. 109–111. In both clays, but rare.

Truncatulina d'Orbigny [1826].

Truncatulina lobatula (Walker and Jacob), plate XVI. fig. 12*a–c*. *Nautilus lobatulus* Walker and Jacob, 1798, Adams' Essays, Kannmacher's edit., p. 642, plate xiv. fig. 36.—Characteristic specimens of this variable form. Rare; black clay; also at Chelsea.

Truncatulina refulgens (Montfort), plate XVI. fig. 13*a–c*. *Cibicides refulgens* Montfort, 1808, Conchyl. Syst., i. p. 122, 31^{e} genre.—Our figure closely corresponds with d'Orbigny's modèle No. 77. Rare; brown clay; also at Chelsea.

Planorbulina d'Orbigny [1826].

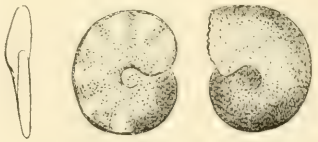
Planorbulina ammonoides (Reuss), plate XVI. fig. 14*a–c*. *Rotalina ammonoides* Reuss, 1845, Verst. Böhm. Kreideform., pt. 1, p. 36, plate viii. fig. 53; plate xiii. fig. 66.—The *Planorbulinæ* offer great difficulties in grouping, on account of their variation. *Pl. ammonoides* may be described as having rounded

chambers, and the whole shell generally symmetrical and depressed, sometimes concave at each umbilicus. Rare; in the brown clay. Also at Chelsea.

Planorbulina complanata (Reuss) var., plate XVI. fig. 15*a–c*. *Anomalina complanata* Reuss, 1851, Haidinger's Nat. Abh., Bd. iv. plate iv. fig. 3.—An example somewhat nearer our form was figured and described by Reuss in his paper on 'Hils und Gault,' * under the name of *Rosalina complanata*.

Planorbulina rotula (d'Orbigny). Woodcut, fig. 155. *Anomalina rotula* d'Orbigny, 1846, For. Tert. Vienne, p. 172, plate x. figs. 10, 11.—A much compressed, many-chambered variety; in our specimen the septation is indistinct. One specimen; brown clay.

Fig. 155.



Planorbulina Ungeriana (d'Orbigny) var., plate XVI. fig. 16*a–c*. *Rotalina Ungeriana* d'Orbigny, 1846, Foram. Tert. Vienne, p. 157, plate viii. fig. 16.—Our specimen, in spite of its ornamentation of riblets on the spire, agrees generally with d'Orbigny's figure. Bornemann figures in 'Septarien-thon Hermsdorf,' Z. d. geol. Ges., 1855, vii., plate xvi. fig. 5, a form in which the ornamentation appears to be a granulate boss. We have the normal type, but do not figure it. It is not rare in our washings. Brown clay; also at Chelsea.

Planorbulina Haidingeri (d'Orbigny) var., plate XVI. fig. 17*a*, *b*. *Rotalina Haidingeri* d'Orbigny, 1846, For. Tert. Vienne, p. 154, plate viii. figs. 9–11.—Sowerby, in Wetherell's paper (op. cit.), figures this small Rotaline, and describes it, with others, as *Rotalia*. We have examined our specimens carefully, and have come to the conclusion that it is a dwarfed and poor form, and may be safely described as a variety of *P. Haidingeri*.† It is of frequent occurrence in the London Clay, but in our washings we have found it only in the black bed.

Fig. 156.

Anomalina, sp. Woodcut, fig. 156. Unfortunately broken and lost after this drawing was made. It is near *Truncatulina grosserugosa* Gümbel. From the black clay.

Pulvinulina Parker and Jones [1862].

Pulvinulina repanda (Fichtel and Moll), plate XVI. fig. 18 *a–c*. *Nautilus repandus* Fichtel and Moll, 1803, Test. Micr., p. 35, plate iii. figs. *a–d*. Rare; brown clay; also at Chelsea.

* SB. K. Akad. Wiss. Wien, xlvi. (1863) p. 86, pl. xi. fig. 3.

† See also Geologist, vii. (1864) p. 87, and Catal. Foss. Foram. Brit. Mus., 1882, pp. 21 and 90.

Pulvinulina repanda (Fichtel and Moll) var. *concamerata* Williamson, plate XVI. fig. 19 *a–c*. *Serpula concamerata* Montagu, Test. Brit., Suppl., p. 160 (*fide* Williamson). *Rotalina concamerata* Williamson, 1858, Recent. For. Gt. Brit., p. 52, plate iv. figs. 102–3.—A limbate variety of *P. repanda*. Rare; brown clay.

Pulvinulina Boueana (d'Orbigny) plate XVI. fig. 20*a–c*. *Rotalia Boueana* d'Orbigny, 1846, Foram. Tert. Vienne, p. 152, plate vii. figs. 25–27.—A much ornamented form, having a delicate, thin keel. Extremely abundant, and varied in its ornamentation, in the black clay, and not met with in the brown.

Pulvinulina Karsteni (Reuss), plate XVI. fig. 21 *a–c*. *Rotalia Karsteni* Reuss, 1855, Z. d. geol. Ges., vii. p. 273, plate ix. fig. 6.—Rare; brown clay.

Pulvinulina punctatula (d'Orbigny) varr., plate XVI. figs. 22*a–c* and 23*a–c*. *Rotalia punctatula* d'Orbigny, 1826, Tabl. Méthod., p. 273, No. 25; modèles, No. 12. We have placed these two examples together, believing them to be varieties of the same form. From the brown clay.

Sub-family Tinoporinæ.

Tinoporus Montfort [1808].

Tinoporus baculatus Montfort (Carpenter), plate XVI. fig. 24. Montfort, 1808, Conchyl. Syst., i. p. 146, 37e genre. Carpenter, 1860, Phil. Trans., p. 557, plates xviii. and xix.—A small example of this form, with a granular surface, occurred. Our specimen is comparable with Dr. Carpenter's figure in Introd. Foram., plate xv. fig. 8. One only found; black clay.

In the following table will be found a complete list of all the Foraminifera at present known to occur in the London clay. We have noted the localities and the authority for their occurrence, and have given our Piccadilly specimens in a separate column, noting their relative abundance.

The following books and memoirs include references to the Foraminifera of the London clay:—

1834, Wetherell, T. N., "Observations on a well dug on the south side of Hampstead Heath" [the Foraminifera figured and partly described by J. De C. Sowerby], Trans. Geol. Soc., 1834, ser. 2, v. p. 131, plate ix. figs. 3–10 and 12–20.

1864, Jones, T. Rupert, and Parker, W. Kitchen, "On the Foraminifera of the London Clay [of Middlesex and Surrey]," Geologist, 1864, vii. pp. 85–88. This paper deals with the nomenclature of Wetherell's figures, he having merely indicated the genera and gives a list of all known forms.

1854, Prestwich, Joseph, "On the Thickness of the London

Clay; on the Relative Position of Fossiliferous Beds of Sheppey, Highgate, Harwich, Newnham, Bognor, &c.; and on the Probable Occurrence of the Bagshot Sands in the Isle of Sheppey," Quart. Journ. Geol. Soc., 1854, x. pp. 401–19. Lists of the Foraminifera given on pp. 417 and 419.

1872, Whitaker, William, Memoirs of the Geological Survey of England and Wales, vol. iv. The Geology of the London Basin. 8vo, London, 1872. List of Foraminifera by Jones and Parker.

1878, Shrubsole, W. H., "On the New Town-Well at Sheerness" [with a] "List of Fossils found in the London Clay," Proc. Geol. Assoc., 1876–8, v. pp. 355–62. (No authors' names given to the species.)

1882, Jones, T. Rupert, Catalogue of the Fossil Foraminifera in the Collection of the British Museum. 8vo, London, 1882.

The following arrangement of initial letters will show the localities where the fossils were described from or noticed as occurring, and will also indicate the author responsible.

From Mr. Wetherell's collection (described in detail by Jones and Parker, 1864, Geologist, vii. pp. 85–89): H.W., Hampstead Well; H.H.F., Hampstead, Highgate, and Finchley.

From Messrs. Jones and Parker's collection (Geologist, op. cit.): C.F., Copenhagen Fields; C.T., Chelsea, bed of Thames; C., Clapham; W., Wimbledon Common.

Mr. Shrubsole's collection (Proc. Geol. Assoc., op. cit.): S., Sheppey.

Messrs. Sherborn and Chapman's collection: Ch., Chelsea, at the foot of Stanley Railway Bridge; the Piccadilly specimens appear in a separate column at the end of the table.

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Biloculina depressa d'Orb.	W.	
Spiroloculina excavata	S.	
„ planulata	S.	
Miliolina (Triloculina) oblonga Mont.	C.F., W.	
„ „ trigonula	S., Haverstock Hill (Cat. For. Brit. Mus., p. 19).	
„ „ communis Desh. ..	..	2, new to London Clay.
„ „ circularis Born.	..	1, new to London Clay.
„ (Quinqueloculina) seminulum Linné	S.	1.
„ „ secans d'Orb. ..	S.	1.
„ „ triangularis d'Orb.	H.W., H.H.F., C.F., W.	
„ „ bicornis	S.	

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Miliolina (Quinqueloculina) Ferussacii d'Orb.	S.	1.
„ „ agglutinans	S.	
„ „ sp. near *lyra* d'Orb.	Haverstock Hill (C.F.B.M., p. 19)	
Cornuspira involvens	S.	
Lituola nautiloidea Lamk.	C.F., C.T.	
Trochammina incerta d'Orb.	H.W., C.F., W., S.	
Textularia agglutinans d'Orb.	C.F., C.T., W., S.	1.
„ turris d'Orb.	C.F.	
„ abbreviata d'Orb.	W.	
„ carinata d'Orb.	H.H.F., C.F., C.T., W.	
„ sagittula	S.	
„ difformis	S.	
„ variabilis	S.	
Verneuilina tricarinata d'Orb.		1, new to London Clay.
„ Muensteri	S.	
Bigenerina (Vulvulina) capreolus d'Orb.	Ch.	Very abundant, new to L. C.
„ nodosaria	S.	
Gaudryina pupoides d'Orb.		Not rare.
Clavulina (Verneuilina) communis d'Orb.	H.W., H.H.F., C.F. C.T., W.	Abundant.
Bulimina ovata d'Orb.	C.F., C.T., W.	
„ pyrula	S.	
„ pupoides	S.	
„ variabilis	S.	
„ affinis d'Orb.		1, new to L. C.
Virgulina squamosa	S.	
Bolivina punctata d'Orb.	W.	Abundant.
Cassidulina subglobosa Brady		1, new to L. C.
Lagena globosa Mont.	S.	4.
„ lævis Mont.	S.	3.
„ apiculata Reuss		3, new to L. C.
„ vulgaris Will., v. oxystoma Reuss		1, new to L. C.
„ aspera	S.	
„ striata d'Orb.	S.	2.
„ sulcata W. and J.	S.	1.
„ melo	S.	
„ marginata	S.	
„ (Obliquina) oviformis S. and C.		5, new sp.
Nodosaria (Glandulina) glans	S.	
„ „ abbreviata Neug.		Not rare, new to L. C.
„ „ obtusissima Reuss		4, new to L. C.
„ „ semicostata S. and C.		1, new sp.
„ radicula Linné	C.F., C.T., W., S.	Rare.
„ humilis Roem.	C.F., C.T., W.	1.
„ pyrula d'Orb.	C.F., C.T., W., S.	
„ ovicula d'Orb.	C.F., C.T., W., S.	
„ arundinea Schw.	Ch.	Rare.
„ longiscata = ? arundinea	C.F., C.T., W.	
„ longisecta = ? longiscata	S.	
„ soluta Reuss	(?) Haverstock Hill (C.F.B.M., p. 20)	Very rare.

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Nodosaria ovulata S. and C.	..	Rare, new.
,, subornata Reuss	..	1, new to L. C.
,, clavata Costa	..	1, new to L. C.
,, hispida d'Orb.	S.	2.
,, hirsuta d'Orb.	W.	
,, spinosa d'Orb.	Islington (C.F.B.M., p. 20)	
,, scalaris	S.	
,, raphanus Linné	H.W., W., S. ..	2.
,, ,, v. Zippei Reuss	Haverstock Hill (C.F.B.M., p. 20)	
,, raphanistrum Linné	H.W., C.F., C., W. (these specimens include N. bacillum, N. affinis, and N. badenensis)	1.
,, affinis d'Orb.	..	Not rare.
,, bacillum Defr.	Ch...	Not rare.
,, badenensis d'Orb.	H.W., C.F., C., W.	Rare.
,, polygona Reuss	Ch.	New to L. C.
Dentalina communis d'Orb.	H.W., C.F., C.T., W.	Rare.
,, ,, v. guttifera d'Orb.	Haverstock Hill (C.F.B.M., p. 20)	
,, elegans d'Orb.	H.W., C.F., C.T., W., Ch.	1.
,, consobrina d'Orb.	C.F., C., W.	
,, pauperata d'Orb.	C.F., C., W., S.	2.
,, obliqua	S.	
,, brevis d'Orb.	W.	
,, inornata d'Orb.	..	Fragments, new to L. C.
,, Buchii = intermittens Rœm.* ..	H.W.	
,, abnormis Reuss	..	1, new to L.C.
,, adolphina d'Orb.	S.	Very abundant.
,, spinulosa Mont.	H.W., C.F., C., W., Ch.	Abundant.
,, acuta d'Orb.	Quoted by Prestwich as occurring at Copenhagen Fields in Q.J.G.S., vol. x. p. 47.	
,, acicula Lamk.	C.F., C., W.	1.
,, acuticosta Reuss	W.	
,, multilineata Born.	..	2, new to L. C.
,, obliquestriata Reuss	..	1, new to L. C.
,, vertebralis Batsch	..	2, new to L. C.
Rhabdogonium tricarinatum d'Orb.	..	1, new to L. C.
Marginulina glabra	S.	
,, lituus d'Orb.	C.F., W.	
,, bullata Reuss	..	1, new to L. C.
,, similis d'Orb.	Haverstock Hill (C.F.B.M., p. 20)	

* Noted in Whitaker's 'London Basin,' p. 596. These are most probably the two single spherical chambers we refer to under our description of N. soluta Reuss.

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Marginulina Wetherellii Jones	H.W., H.H.F., C.F., C.T., C., W., Ch., S.	Very abundant.
Vaginulina legumen (Linné)	S.	
„ „ „ var.	..	1, new to L. C.
„ linearis Mont.	W.	
Cristellaria obtorta Terq.	..	1, new to L. C.
„ crepidula F. and M.	W., S.	1.
„ acutauricularis F. and M.	..	1, new to L. C.
„ italica Defr.	H.W., C.F., S. ..	2.
„ „ Defr. v. spinulosa S. and C.	..	2, new var.
„ rotulata Lamk.	H.W., H.H.F., C.F., C., W., S., Ch.	1.
„ „ v. flexuosa S. and C. ..	..	1, new var.
„ inornata d'Orb.	..	Rare, new to L. C.
„ cassis F and M.	W.	
„ cultrata Montf.	H.W., H.H.F., C.F., C., W., Ch.	Very abundant.
„ „ v. splendens S. and C. ..	..	1, new var.
„ megalopolitana Reuss	..	1, new to L. C.
Polymorphina gibba d'Orb.	..	1, new to L. C.
„ gutta d'Orb.	..	1, new to L. C.
„ (Globulina)	Quoted by Prof. Prestwich as occurring at Copenhagen Fields in Q.J.G.S., vol. x. p. 417.	
Uvigerina pygmæa	S.	
„ asperula Czjzek	..	Abundant, new to L. C.
Globigerina bulloides d'Orb.	W., S.	Abundant.
Orbulina universa d'Orb.	S.	1.
Pullenia sphæroides d'Orb.	W.	
Cymbalopora Poeyi	S.	
Discorbina rosacea d'Orb.	S.	Rare.
„ globularis	S.	
Truncatulina lobatula W. and J.	H.H.F., W., S., Ch.	Rare.
„ refulgens Mont.	Ch.	Rare, new to L. C.
Planorbulina ammonoides Reuss	C.T., W., S., Ch. ..	Rare.
„ complanata Reuss	..	Rare, new to L. C.
„ rotula d'Orb.	..	1, new to L. C.
„ Akneriana d'Orb. = Pulv. Boueana d'Orb., q. v.	H.W.	
„ Ungeriana d'Orb.	H.W., H.H.F., C.F.? C.T., C., W., S., Ch.	Not rare, also var.
„ Haidingeri d'Orb. var.	H.W., C.F.? C.T., W., S.	Not rare.
Anomalina, sp.	..	Very rare, new to L. C.
Pulvinulina repanda F. and M.	Ch.	Rare, new to L. C.
„ „ v. concamerata Will. ..	Ch.	Rare, new to L. C.
„ Boueana d'Orb.	(H.W.)	Very abundant.
„ elegans d'Orb	C.T., W.	
„ Micheliniana d'Orb.	W.	

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Pulvinulina Karsteni Reuss	..	Very rare, new to L. C.
,, punctatula d'Orb.	..	Rare, new to L. C.
Rotalia Beccarii	S.	
,, Soldanii	S.	
,, orbicularis d'Orb.	C.T., W.	
Tinoporus baculatus Montf.	..	1, new to L. C.
Nonionina communis	S.	
,, umbilicatula	S.	
Polystomella striato-punctata	S.	

In addition to the above list we find in Professor Prestwich's paper on "The Thickness of the London Clay," Q.J.G.S., x. p. 417, mention made of *Robulina* from Copenhagen Fields and Haverstock Hill, and *Rosalina* from Highgate. It is most probable that these forms have been included in Messrs. Jones and Parker's lists, under the genera *Cristellaria, Planorbulina,* &c.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Oogenetic Studies.‡—Dr. L. Will, in the first of his oogenetic studies, deals with the history of the ovum of *Colymbetes fuscus*.

Treating first of the primordial ovum and its conversion into a multicellular ovarian mass, he describes the former as similar to that of other animals and especially of Vertebrates; in its development, however, it exhibits some interesting and characteristic peculiarities. The nucleus of the primordial ovum gives rise to large daughter-nuclei, and these become the nuclei of those elements which are ordinarily called yolk- or nutrient-cells, but to which Dr. Will applies the term of giant epithelial cells, as they have absolutely nothing to do with nourishment or with yolk-formation. They pass to the periphery of the egg, but not in such a way as to form a closed follicle round it; they rather occupy one side of the egg; the large ovarian nucleus is thus pressed towards the opposite side of the cell, and a longitudinal axis becomes apparent later on. Smaller daughter-nuclei are also formed, and these become the nuclei of the true epithelial cells or those which will, later, surround the egg with a continuous follicle. At first the primordial ovum is undoubtedly a single cell, but on the formation of daughter-nuclei it loses its unicellular character, and at the time when all the large daughter-nuclei are formed the primitively unicellular primordial ovum becomes a multicellular ovarian rudiment; the true ovum is formed solely by a single cell of this mass, and by the one which contained the primitive ovarian nucleus, and which

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with processes of Evolution, Development, and Reproduction, and with allied subjects.

‡ Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 329–68 (2 pls.).

becomes inclosed by the follicular epithelium; this may be called the follicular ovum. It must not, as it ordinarily is, be regarded as equivalent to the primordial ovum, but as forming a part only of it; it is the primordial ovum after the loss of the daughter-cells.

The history of the ovarian nucleus is next entered on; from his observations the author is led to conclude that the protoplasmic body of the ovarian cell constantly grows in a centrifugal direction at the cost of the nucleus; in *Colymbetes* this is at first quite regular, for continuous superficial layers of the nucleus are added to the protoplasmic body in the form of rings; later on, this process of growth is localized in certain parts of the periphery of the nucleus, and in this way bays and buds appear on its surface. As the process goes on these become more and more irregular. Towards the end of egg-formation this growth gradually ceases. Looked at morphologically, these phenomena teach us that there is no "dualism" in the cell; there is no real distinction between nucleus and cell-body; the conclusion to which we are led is that there was a stage in which the whole cell was still nucleus.

The history of the protoplasmic body forms the subject of the last division of this essay. It is at first quite clear and achromatic, and appears to be exactly similar to the substance of the nucleus; with increasing age it becomes chromatic; later on it becomes spotted owing to the formation of vitelline elements, which are all formed in and by the egg itself. The giant and smaller epithelial cells appear to be the homologues of the cells which, in the male, do not atrophy, but form the spermatozoa. In the female they have no function, but are only of historical interest, indicating, as they seem to do, the primitive hermaphroditism of the primordial ovum.

Embryology of Armadillos.*—It is a belief among the people of South America that armadillos bring forth only male young. Dr. H. v. Ihering communicates the results of some important observations he has made on this and other points in the history of development of the armadillo, *Praöpus hybridus*. He states that all the fœtuses taken from two females presented the external characters of males only. He also states that several fœtuses—six or more—are inclosed in a single chorion, which is surrounded by as many zonary placentæ as there are fœtuses, the placentæ not, however, forming perfect zones. He finds that the ungual phalanges at this period differ entirely from that of the adult. Instead of being long and claw-shaped, they are wide and hoof-shaped, with a trilobate margin, as in the extinct genus *Gyptodon*. This is highly interesting, as exhibiting the law of acceleration modifying that of heredity. The sexual characters are probably like those of the hyænas, in that the female fœtus has a clitoris so large as to give her a close resemblance to the male.

Post-embryonic Development of Vitelline Sac of Birds.†—MM. Charbonnel-Salle and Phisalix had their attention directed to the

* Amer. Natural., xx. (1886) pp. 667–8. (Reported by Mr. E. D. Cope from 'Kosmos.')

† Comptes Rendus, cii. (1886) pp. 1496–8.

vitelline sac of birds by happening to discover in the peritoneal cavity of young pigeons a soft yellowish mass which appeared to be a foreign body. In the pigeon the vitelline pedicle atrophies before birth, and the cord undergoes torsion, and soon becomes obliterated; about a month after the young leave the egg the pedicle breaks and the sacs become free. Later on it forms adhesions with the viscera, becomes enveloped by vessels and is completely absorbed. In the chick and the duck the vitelline pedicle persists, and as it shortens it draws the sac with it; the latter never becomes free; it is rapidly absorbed. It would appear that the absorption of yolk is most active in those which lead a free life on leaving the egg. The author gives a detailed account of the changes which occur in the pigeon.

Oviposition in Phyllomedusa.*—Dr. H. v. Ihering finds that *Phyllomedusa Iheringii* lays its eggs, not in water, but on the overhanging leaves; the masses of eggs are wrapped between two leaves, in such a way as to leave an opening only below. He thinks that the tailed larvæ drop into the water; but owing to the drying up of the leaves, he was unable to follow the development of the eggs. This mode of oviposition constitutes a passage to that of *Hylodes*, in which the whole development takes place in the air.

Mr. G. A. Boulenger, in some remarks upon Dr. von Ihering's note, refers to the arboreal frog, *Chiromantis rufescens*, belonging to the family Ranidæ, which, though widely remote from *Phyllomedusa*, lays its eggs in a similar way. Mr. Boulenger gives a useful synoptic table, showing the facts known as to the mode in which the Anura deposit or protect their offspring.

Influence of Variations in the Physico-Chemical Medium on the Development of Animals.†—M. E. Yung gives the results of numerous experiments made by him upon tadpoles under various conditions.

The fewer tadpoles there are in a given quantity of water, in otherwise similar conditions, the sooner do they develope into young frogs. Tadpoles develope more quickly in a shallow and wide vessel of water than in a narrower and deeper vessel. This is partly due to the greater aeration of the water, and partly to the less distance to be traversed in order to reach the surface. The author discusses the influence that food has upon the sexuality of the animal, and after citing several writers, gives his opinion that unisexual forms are derived from hermaphrodite ancestors. He refers to the various opinions as to the time at which the indifferent genital organ of the embryo takes on its male or female character, as a result of the development of the one kind of cell and the disappearance of the opposite kind in the gonad. As a rule, in a given number of eggs only a slightly greater percentage of females are developed, but this number can be increased by feeding the tadpoles with meat, and still more so by means of a fish diet.

* Ann. and Mag. Nat. Hist., xvii. (1886) pp. 461–4.
† Arch. Sci. Phys. et Nat., xiv. (1885) pp. 502-22.

In sea-water tadpoles soon die, but in a dilute solution (0·2 to 0·8 per cent.) of the salts of sea-water development will take place, though very much more slowly than in fresh water. By the production of artificial waves, development can be procured even in more concentrated solutions.

Development of Food-Fishes.*—Mr. E. E. Prince has studied, and reared from the ova, embryos of *Gadus merlangus*, *G. æglefinus*, *G. morrhua*, *Trigla gurnardus*, *Pleuronectes flesus*, and *P. limanda*.

With the exception of the herring, the ova of the principal food-fishes are pelagic, and when mature are almost identical in appearance and structure. The young ovarian ovum is more or less opaque, but becomes more transparent as it approaches maturity; it then exhibits the following structures:—(*a*) A homogeneous yolk, destitute of large globules, except in *T. gurnardus*; (*b*) a delicate cortical film of protoplasm; (*c*) a space or breathing chamber, separating the vitellus from (*d*) the external capsule or yolk-sac. This capsule is hyaline, tough, destitute of pores or striations, although thin and transparent; its thickness varies in different species; it is pierced by one aperture, having an hourglass shape. These pelagic ova show no tendency to adhere together, but float freely and separately; in still water they may congregate in masses. If no spermatozoa come near them, they become opaque and sink; the entrance of spermatozoa has never been seen, but one is probably sufficient, and enters the micropyle.

The "blastodisc" is formed on the pole of the egg which is carried downwards, contrary, therefore, to what happens in amphibian ova; the vitellus revolves freely in the "yolk-sac" so that the blastodisc can always regain its ventral position when disturbed. Segmentation goes on in such a way that more or less irregular cells are produced; this is not confined to the blastodisc, but new cells are formed apparently in the periblast, which then become added to the disc. The exact mode of development of the blastodermic rim is uncertain; a thickening of this rim is produced corresponding to a radius of the blastodisc; this thickening is the rudiment of the embryo. In the formation of the nerve-cord, no trace is found of a medullary groove or growing-in of the corneous layer as described by Calberla, but a fissure appears later on by dehiscence. The notochord has been formed from hypoblast, and now becomes detached; posteriorly it is continuous with an undifferentiated mass of cells. Close on each side of the notochord are the mesoblast cells. The cephalic end of the embryo is fixed, but the caudal end advances with the blastoderm. The tail lies sideways on the yolk, and continues in this state of torsion till the embryo is free.

Nothing particular is noticed about the development of sense-organs, which, as is well-known, appear as solid instead of as hollow, outgrowths. The notochord is surrounded by a cuticular sheath, secreted by the outermost cells; round this a mesoblastic sheath is

* Ann. and Mag. Nat. Hist., xvii. (1886) pp. 443-61.

deposited, which probably consists only of *membrana elastica interna*, though a *membrana limitans externa* may sometimes be present. The pectoral fins appear early, as a fold of epiblast into which mesoblast protrudes.

The paper concludes with certain diagnostic features and details, by which the ova of various food-fishes can be distinguished—such as size, shape, character of capsule, &c. In the embryos the pigmentation has some diagnostic value; the most favourable conditions for hatching the eggs, such as temperature, the chemical purity of the water, and so on, are given. The author draws this conclusion from his study of the development of fishes, "that the Teleostei embryologically, as also morphologically, are a highly specialized group, and are too far removed from the primitive or protichthyoid type to yield much material for broad generalizations." Though Teleostean embryology has not the interest possessed by Selachian development, it is nevertheless of very great practical importance.

Biology of the Trout.*—Dr. D. Barfurth has investigated some of the reproductive relations of the trout, especially in regard to sterility and degeneration.

The sterility of the trout is temporary.—By careful observation he has been able to demonstrate that the majority of sterile specimens become mature by the next spawning-time, though some forms require at least two years to become ripe for spawning. The sterility, though temporary, may extend over two spawning periods.

The most important cause of this temporary sterility is the prevention of spawning. When the ripe elements are not liberated, for various reasons, e. g. want of suitable depositing ground, unfavourable temperature, nutrition, &c., degeneration and reabsorption set in with the result that hypertrophied organs become sterile. If the reproductive products are retained for several spawning periods successively, the organs begin to exhibit a connective-tissue degeneration, and a permanent sterility may ensue. The absorption of the unexpelled reproductive elements is preceded by simple dissolution, or by fatty and mucous degeneration. The white blood-corpuscles do not seem to play any, or at least no important part in the absorption; their appearance is merely a secondary accompaniment.

The degeneration of the elements is next described in detail. Even in normal conditions a follicular degeneration occurs in the ovary of the trout. The granulosa cells proliferate and perhaps enlarge, while the yolk exhibits fatty degeneration. The formation of new reproductive elements is affected by the necessary absorption of older unexpelled eggs and sperms, and advances in proportion to the progress of the latter process. The evil influence of the hindered spawning is not confined to modifying the ovary, for it has been proved further that the mature elements afterwards produced result in degenerate organisms; the fertilized ova of such pond-trout produced relatively weak forms. The value of the research is increased by a wide survey of relative literature.

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 128–78 (2 pls.).

Physiological Selection.*—Mr. G. J. Romanes finds certain difficulties in regarding natural selection as a theory for the origin of species, as it is rather a theory of the origin of adaptive structures. He proposes to replace it by what he calls physiological selection, or segregation of the fit. His view is based on the extreme sensitiveness of the reproductive system to small changes in the conditions of life, and he thinks that variations in the direction of greater or less sterility must frequently occur in wild species. If the variation be such that the reproductive system, while showing some degree of sterility with the parent form, continues to be fertile within the limits of the varietal form, the variation would neither be swamped by intercrossing, nor die out on account of sterility. When a variation of this kind occurs the physiological barrier must divide the species into two parts. The author, in fine, regards mutual sterility not as one of the effects of specific differentiation, but as the cause of it.

"F. J. B" in the 'Athenæum' † points out that naturalists have long recognized that there are "morphological" and "physiological" species. The former have their origin in men's minds, the latter in a series of changes sufficient to affect the internal as well as the external organs of a group of allied individuals. The "physiological selection" of morphological species is a confusion of ideas; that of physiological species a redundancy of terms.

γ. General.‡

Ancestry of the Chordata.§—Mr. W. Bateson, in an essay on this subject, commences by discussing the segmentation of *Amphioxus* and the vertebrates as compared with that of annelids; this is a phenomenon that has been insisted on as proving the genetic affinity of the two groups; when it is investigated, however, we find that greater or less repetition of various structures is one of the chief factors in the composition of animal forms, that one or many organs may be affected, and that this repetition may be at first irregular, culminate in regularity, and again vary. The fact that the gonads are so often repeated, tends to show that the repetition first arose in adult life; even at this present epoch, many repetitions still appear at a late period only.

In the Chordata it is to be noted that the mesoblastic plates are at first unbroken, the medullary plate has no transverse divisions, and the excretory ducts are single tubes with single openings. Further, it is important to observe that of the characteristic organs of the Chordata, the notochord is always unsegmented, while it is almost the earliest organ formed; the medullary plate does not exhibit any serial repetition till the peripheral nerves arise, and in *Amphioxus*

* Journ. Linn. Soc. Lond., xix. (1886) pp. 337–411.

† No. 3069 (Aug. 21, 1886) pp. 242–3.

‡ This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

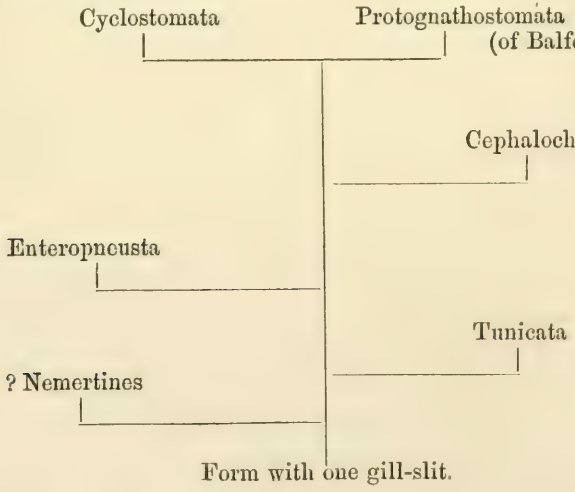
§ Quart. Journ. Micr. Sci., xxvi. (1886) pp. 535–72.

and the Marsipobranchs the repetition is not regular and opposite. The gill-slits are, by their nature, repeated structures, but as they, and *à fortiori* their repetition, arose within the limits of the Chordate group this fact does not weigh against Mr. Bateson's theory that the primitive members of it were unsegmented.

The author next discusses the Enteropneusta as members of the Chordata, and points out that the three features which distinguish the Chordata from other animals are present in *Balanoglossus;* the central nervous system arises by longitudinal delamination from the skin in the dorsal middle line, there is a hypoblastic notochord at the anterior end, and the gill-slits are formed as regular fusions and perforations of the body-wall and gut from before backwards. Mr. Bateson objects to the suggestion that the lancelet and the Marsipobranchs are degraded forms, and points out that in Ascidians the change, though well-marked, is not a deviation from a segmented to a less segmented form.

It seems certain that the primitive Chordata were of aquatic habit, led a free life, and possibly burrowed; the mouth had primitively a ventral direction, the skin was ciliated; the nervous system of *Balanoglossus*, *Amphioxus*, the lampreys, and *Myxine* form a graduated series leading up to the conditions found in higher vertebrates, and showing the evolution of the system from a solid cord in the skin to a close tube whose walls give off a series of "segmental" nerves.

As to the affinities of the Chordata, we can only say, as regards the Echinodermata, that *Tornaria* is practically identical with *Bipinnaria;* it is still a matter for inquiry whether the resemblances to the Nemertinea are indications of genetic affinity. The relations of the Chordata *inter se* may be shown by the following table:—



B. INVERTEBRATA.

Marine Fauna of the South-west of Ireland.*—The first report of the Committee to investigate the fauna of the hundred fathom line off the south-west coast of Ireland has been published. Dredgings were made at thirteen stations. Of the Foraminifera sixteen species are new to the British fauna; *Halcampa arenacea* and *Chitonactis expansa* are new species of Malacozoa; *Ophiothrix luetkeni* was found to be a characteristic of the deeper water.

One hundred and thirty-three species of Mollusca have as yet been identified. Of the Ostracoda found, *Kirthe glacialis* has not been previously recorded as recent.

Ectoparasites of the Gills of Gammarus pulex.†—The first ectoparasite from the gills of *Gammarus pulex*, described by Dr. L. Plate, is *Dendrocometes paradoxus*. The transparent cuticle has generally, though not always, a double contour. The body substance is not distinguishable into a cuticle and a medullary substance. In addition to the granules which are found in all Acinetæ, there are granules which vary greatly in number and size, and are distinguishable from the fat-like grains by the deep stain which they take with safranin. The author calls them "Tinkturkörper." They do not blacken with osmium. Their origin and functions are still unknown. In addition to these there may be yellowish-brown or green granules. With regard to the number of arms or suckers the author states that in several hundred specimens he never found more than four, and that these always stand in quite definite relation to one another, and to the contractile vacuoles. The arms are not quite stiff, but can be withdrawn into the parenchyma of the body. There is an axial canal in the arms which can always be made out in well-preserved specimens. From the contractile vacuole there is given off a delicate canal which opens on the surface of the body. The nucleus is oviform or oval; there is a distinct nuclear membrane, and the nucleus itself is finely or coarsely granular. After describing the reproduction of the so-called embryos, and the mode of conjugation, the author discusses the relation of *D. paradoxus* to the other Acinetidæ, and suggests the division of the class into two groups, which he calls Fasciculifera and Radiformia; the former contains *Ophryodendron* and *Dendrocometes;* the latter *Sphærophrya*, *Podophrya*, *Acineta*, *Dendrosoma*, and *Urnula*. Reproduction is effected solely by the formation of internal buds. This is preceded by the elongation and fibrous differentiation of the nucleus, which is followed by the formation of a second contractile vacuole. Part of the surface is invaginated to form a flask-shaped cavity, which closes later on. This developes four equatorial bands of cilia. The lower surface bulges out in the form of a broad knob, and, after the complete division of the nucleus it separates completely from the parent organism.

* Proc. R. Irish Acad., iv. (1886) pp. 599–638.

† Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 175–241 (2 pls.).

The next form examined is *Spirochona gemmipara*, which has been carefully studied by Hertwig. Some additions to our knowledge are made, especial attention being given to the conjugation of this species.

Lagenophrys ampulla is a Vorticelline which does not appear to have been studied since it was described by Stein. There is no specially differentiated cortical layer, but the protoplasm of fresh specimens exhibits very lively streaming movements, which cease if the animal is kept under unfavourable conditions. Two parts are to be distinguished in the œsophagus, which are separated from one another by a constriction which varies in width at various times. Just in front of the left wall of the anterior portion there is a long seta which appears to serve as a tactile organ. The sausage-shaped nucleus is, as a rule, finely granulated, but contains sometimes a number of nucleoli. A spindle-shaped or rounded nucleolus is always attached to it, but is not constant in position. The species is only produced by a process of fission, which has been accurately described by Stein.

In his fourth chapter the author discusses the essential nature of conjugation, and the significance of the nucleoli in the ciliated Infusorians. There are a great number of variations in the phenomena of conjugation, and it is as yet impossible to say why, in one Infusorian the nucleus breaks up, and in another is wholly or partially retained. The object of conjugation appears to be the restoration of the balance between the cyto- and nucleo-idioplasm. This is effected by the respective changes which take place between two individual infusorians. In many cases only those ciliates conjugate which have not attained the normal size. It is conceivable that while, during repeated divisions, the cytoplasm may be sufficiently well nourished, nucleo-idioplasm may be insufficiently so. There are observations which support the supposition that the idioplasm of the cell may pass over into that of the nucleus. The hypothesis suggested explains why it is that conjugation periodically alternates with division, and why the nucleus undergoes such deep-seated changes. Conjugation appears, in a very striking way, to be epidemic, or, in other words, to affect a large number of individuals at the same time. This is possibly due to a sudden alteration in their external relations.

In the fifth chapter the author gives an account of *Calidina parasitica*, with remarks on the Philodinaidæ. The members of this group differ from all other fresh-water Rotifers in a number of characters, and if the group be called the Aductifera, and the rest the Ductifera, we may say that in the Aductifera the gonads are double and consist of two completely closed sacs without efferent ducts. In their continuous yolk-mass there are a number of ovarian nuclei. In the Ductifera the generative apparatus is single; there is a special efferent duct opening into the cloaca, and the germinal is distinct from the vitelline portion of the ovary. In the Aductifera the wheel-organ has still the primitive form, and consists of two ciliated circlets placed one behind the other. Dorsally the body is prolonged into a long retractile proboscis which is provided with a second ciliary apparatus at its anterior end. In the Ductifera the primitive form of the wheel-organ is greatly and variously modified in various species;

there is no dorsal proboscis. The Aductifera have the wall of their mid- and hind-gut formed by a syncytium. The contractile vesicle is not a special appendage of the cloaca, and the nervous system has no lateral palps. In the Ductifera the enteric-wall-cells are polygonal and have a membrane, the vesicle is a special appendage of the cloaca, and there are (except in *Conochilus*) two dorsal and two lateral palps. Male Philodinaids have never yet been found.

Two distinct species of Gregarines are to be found in the intestine and body-cavity of *Gammarus pulex*. They are both Polycystids, and have three distinct body-regions.

Mollusca.

Fertilization in Arion.*—Continuing his researches on the reproductive relations of Gasteropods, Herr. G. Platner has studied the phenomena of fertilization as exhibited in *Arion empiricorum*. After noting some general points, such as the variable period between fertilization and egg-laying, and the appearance of the freshly laid ovum, Herr Platner notes how two yellow cross folds in the uterus of Arion, just below the albumen gland, mark the position where the ovum, at the stage with two segmentation spheres, becomes surrounded by a firm homogeneous layer of albumen. At suitable epochs the whole upper portion of the uterus was removed, hardened for half an hour in chromic-osmic-acetic acid, washed, imbedded in celloidin, cut in sections, and stained lightly with hæmatoxylin and then with safranin.

The cavity of the uterus included many spermatozoa, which almost always lay in the plane of the section, at right angles to the long axis, an arrangement obviously advantageous both for snail and investigator. In the stages examined the polar cells were already formed, and most frequently separated. Their appearance, when attached and when isolated, is described. Three were always present, evidently the result of the indirect division of one of the original two. They possessed distinct membranes in which spermatozoa had occasionally penetrated. A full history of the observations as to polar cells in Gasteropoda is given. Herr Platner regards the process as a necessary preliminary to, but independent of fertilization, consisting essentially on the removal of nuclear constituents to be replaced by the male nucleus.

After describing the egg before and after fertilization—and there is no marked difference—he notes the penetration of the sperm, usually at the vegetative pole, and therefore furthest from the germinal vesicle. The head becomes surrounded by a rapidly widening radiate figure, but the rays are less developed on the side turned towards the nucleus of the ovum. The head itself is slightly modified, is without sharply defined nucleus, and is surrounded by a clear space. It still remains in direct contact with the tail, which has to a large extent been drawn into the yolk, where it is readily noted by its very marked staining. Only one spermatozoon entered at once, if a second

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 32–72 (2 pls.).

gained admission, it was only to disappear. The results of previous investigators as to the penetration of the sperm are critically reviewed.

The sperm head draws ever nearer to the germinal vesicle, and is still followed by the tail. Within the germinal vesicle certain changes have occurred; the nuclear elements no longer exhibit uniform colouring, and have become rounded off into nucleolus-like "karyosomata." These seem at first as if they were colourless, but careful observation shows that the chromatin substance, formerly diffusely distributed, is concentrated in the form of small granules at the periphery. These chromatin elements fuse together afterwards, and thus become more distinct. The karyosomata are, at first, frequently united by unstained bridges, but these subsequently disappear. The contour of the germinal vesicle has meanwhile changed to an irregular one. Its position is still near the periphery of the ovum at the animal pole.

The head of the sperm and the surrounding clear space come to rest within an insinking on the side of the germinal vesicle. In some cases, all trace of a nuclear star, which always indicates activity of some sort, was absent. The chromatin substance of the head soon splits longitudinally. The connection between head and tail is at length severed. Each of the two halves of the head is seen as a round or oval body within the germinal vesicle. Two of the karyosomata of the segmentation nucleus are markedly different from all the others, and may be plausibly regarded as the two sperm elements.

In association with the segmentation nucleus, there is at first only one aster, which lies towards the interior of the egg, so that the nucleus is between it and the periphery of the yolk. The connection of aster and nucleus, the appearance of a second aster and further changes are described in detail, and the results up to this point are again collated with those of previous investigators.

The further phenomena of division are similar to those which Platner has described in the sperm-forming cells of *Helix*. The chromatin grains of the equatorial plate split longitudinally. The opposed couples of granules into which the plate is resolved retreat to the opposite poles. There the constituent elements fuse again into spherical form. At the animal pole first, but soon over the whole yolk, a furrow appears, becoming ever deeper, and dividing yolk and spindle into two halves. The rest of the memoir contains an account of the further steps in segmentation, and some further notice of the spermatogenesis.

Tooth-plates of some Stylommatophora.* — Dr. W. Dybowski has investigated, mainly for diagnostic purposes, the tooth-plates of some Gasteropoda belonging to the Stylommatophora division. The *median plate* of the Pulmonata is throughout so essentially similar, that it is of but little use in diagnosis. Two characteristic forms of *internal lateral* plates are distinguishable; (*a*) those in which the principal tooth is simple (*Succinea*, *Helix*, *Arion*); (*b*) those in which the principal is provided with a distinct median lateral tooth (*Limax*,

* Bull. Soc. Imp. Nat. Moscou, lxi. (1886) pp. 50–63 (3 pls.).

Hyalina, *Vitrina*). The *median lateral* plates are really only transitional between the internal and external laterals, and are only occasionally characteristic. The *external lateral* plates are of most use, not only in distinguishing genera, but groups. For specific diagnosis all the four groups of teeth must be noted. The following provisional grouping is suggested :—

I. Internal lateral plates with a median lateral tooth.
   (*a*) The outer lateral plates hook-like and very long; the cutting edge untoothed (*Limax*, *Hyalina*).
   (*b*) The outer lateral plates hook-like and short; the cutting edge toothed (*Vitrina*).

II. The internal lateral plates *without* lateral tooth.
   (*a*) The external lateral plates are long-stalked (*Succinea*).
   (*b*) The external lateral plates are lamella-like and toothed on their posterior margin (*Helix*, *Arion*).

Histological Structure of the Dorsal Papillæ of Onchidium.*—This preliminary report, by Dr. R. v. Lendenfeld, is founded on sections through specimens of *Onchidium chameleon* Brazier, and *O. Dämelii* Semper.

O. chameleon has small papillæ and no eyes, whilst *O. Danielii* has three eyes on each papilla. The author corroborates Semper's account of the eye : the character of the epithelium of the tubercles is identical in the two species. The eyes multiply by division ; semi-detached eyes with two lenses, but with one pigment layer, are not unfrequent. The lens consists of a single cell, capable of dividing ; the retina is more complicated than is described by Semper. Below the ganglia-cells of the optic nerve are cells containing highly refractive plano-concave bodies. Below these cells are elongated hexagonal cells with pigment-cells at the sides of them ; a concave space is formed at the bottom of each hexagonal cell, and in this space is a conical rod, attached by its broad base to the bottom of the concave space, and tapering gradually to a fine point, which is continued as a fine thread through the centre of the hexagonal cell, and enters the ganglia-cell layer. *O. Dämelii* never retracts its tubercles, however near the forceps, &c., approach. "This might lead one to assume that this animal is far-sighted." The concave lenses at the upper ends of the facets, below the large spherical lens, are secondary, and are produced in order to counteract the excessive power of the main lens in the air ; although this latter would be well adapted for use in the water.

Development of the Gill in Fasciolaria.†—Reserving a detailed description of the complete development of *Fasciolaria tulipa* for a later paper, Dr. H. L. Osborn describes the development of the gill only, an abstract of the paper having been already given,‡ when the Gastropod was called, improperly, *Neptunea*.

The surface views were taken from living specimens, which were

* Proc. Linn. Soc. N. S. Wales, x. (1886) pp. 730–2.
† Stud. Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 219–24 (1 pl.).
‡ See this Journal, v. (1885) p. 226.

then preserved in 0·2 per cent. chromic acid for twenty-four hours, then passed through serial alcohols to 70 per cent., and kept permanently in good condition for surface observation. The gill first appears as a nearly median series of folds of ectoderm on the dorsal surface of the *veliger* larva, quite uncovered by the mantle, which gradually grows over them later on. These gill-folds gradually get drawn into a depression, become plate-like, and get carried downwards and covered by the down-growing mantle; so that the gill now occupies the usual position as a series of plates attached to the inner surface of the mantles hanging into the subpallial chamber. The heart, developed as a space in the mesoderm, is at first in front of the branchial folds, but, as these are carried forwards, comes to occupy the position found in the adult, behind the gill. In the adult the structure of the gill is the same as that found in *Fulgur*—consisting of a series of triangular plates, abutting on the left side on a ridge, which however in this form carries no definite blood-vessel. The osphradium is at the side of the gill, in the usual position. The peculiarity in the development of the gill of *Fasciolaria* lies in the fact that it appears before the mantle, whereas in *Fulgur*, *Crepidula*, &c., the gill arises on the inner side of the mantle; and yet both *Fulgur* and *Fasciolaria* develope alike in the egg-capsule. The author regards the mode of development found in *Fulgur*, &c., as derived and abbreviated from that seen in *Fasciolaria;* there is nothing to lead us to consider that the development in the latter is secondary, but, on the contrary, that all ctenobranchiates are derived from ancestors like the young *Fasciolaria*. Considered solely from the point of view of the gill, the phylogenetic development of this structure is repeated ontogenetically in *Fasciolaria*.

Referring to Lankester's "schematic mollusc," and to the structure of the "ctenidium," and to Spengel's theory that the ctenobranch found in most Gastropods was preceded by a ctenidium, of which one series of filaments has been fused with the mantle and lost, the author considers that in the ctenobranch the condition of a ctenidium has never been reached; that *Sigaretus* leads on to such a condition, which seems to have been arrived at in *Valvata*. Taking, therefore, the gill as a basis of classification, he would divide up the Mollusca into a series which would place those forms with complete ctenidia in the highest place, the simplest condition being found in the larva of *Fasciolaria;* but at the same time the author would not place the ctenobranchiates at the bottom of the prosobranchiates, and the zygobranchiates above them as derived from them, for enough is not at present known of the development of Gastropods with a ctenidium.

Nudibranchs of 'Willem Barents' Expedition.*—Dr. R. Bergh reports on the seven Arctic genus of Nudibranchs collected by the 'Willem Barents'; anatomical notes are appended to the systematic account of the species. *Chlamylla* is a new species, apparently allied to the Coryphellidæ, but the caudal portion is short, the dorsal region

* Bijdragen tot de Dierkunde, xiii. (1886) 37 pp. (3 pls.).

is broad, and the tentacles and rhinophores conical; the new species is called *C. borealis*, and it, like *Campaspe major* sp. n., is at present represented by a single specimen only.

Lamellibranchs of the 'Willem Barents.' *—Dr. J. T. Cattie gives a systematic list of the thirty Lamellibranchs collected during the 'Willem Barents' expedition in 1880 and 1881. In the succeeding anatomical portion he first discusses the nature of the byssogenous organs in several species. The observations of Réaumur on the mode of attachment of mussels are most exact, and those which the author has been able to make on *Dreyssena polymorpha* are almost identical with what both observed in the mussel. He finds that the formation of the byssus is a very simple process; the walls in the lamellæ of the byssiferous cavity incessantly secrete a byssogenous material. The lamellæ in the anterior part of the cavity, which is the narrowest in *Mytilus*, unite and fuse with one another, and since the orifice is still more narrow, they form the round tendon of Réaumur, or what Dr. Cattie calls the trunk of the byssus. When, as in *Dreyssena polymorpha* and *Modiolaria discors*, the orifice is not so well marked, or the lamellæ more irregularly arranged, transverse sections show that the lamellæ of the byssogenous material are twisted, and that they alternate with the lacunæ. As the ventral groove of the foot opens into the byssiferous cavity, and the glands secrete their material at the same point, it is clear that each byssus-thread which is formed in the groove is at once fused with the trunk of the byssus.

The ventral groove and the byssiferous cavity are clothed with an epithelium, which is in most cases ciliated; around them there are grouped glandular cells, the body and nucleus of which are converted into a granular refracting mass. An increase of surface is gained by the development of longitudinal folds, and the number of these lamellæ is considerable in the Mytilidæ and Pectinidæ.

With regard to the much disputed question as to the introduction of water into the circulatory system of Lamellibranchs, the author agrees with Carrière and Barrois that, if water does enter, it certainly does not do so by means of the so-called pori aquiferi, for these are certainly the orifices of more or less degraded byssogenous glands. He agrees with Lankester that the supposed introduction would be a somewhat startling physiological process; the results of injections must be borne in mind together with the motto, "Timeo injectiones et nova ferentes."

Molluscoida.

a. Tunicata.

Classification of the Tunicata.†—M. F. Lahille thinks that the present systematic arrangement of the Tunicata is very artificial; after the presence or absence of a deciduous tail [which is regarded by Gegenbaur as an unimportant character] the most important organ for classification is the gill. The Salpidæ have a single row of holes

* Bijdragen tot de Dierkunde, xiii. (1886) 48 pp. (4 pls.).
† Comptes Rendus, cii. (1886) pp. 1573–5.

on either side of their gill-organ; Doliolidæ have the holes better developed and more numerous; the Didemnidæ have three rows, and the Leptoclinidæ four. In higher types the gill is larger and is placed beside the intestine. In the Thaliacea the respiratory organ is very simple, and without papillæ; the forms in which the gill is simple may be grouped together as the Aplousobranchiata. The second natural sub-class is that of the Phlebobranchiata, in which the gill is provided with longitudinal vessels. The third and last, or that of the Caducichordata, have longitudinal folds on the gills, for which reason they are denominated the Stolidobranchiata. The progressive complication of the gill is stated to correspond to an increase in the differentiation of the whole Ascidian organism, and the proposed classification is not therefore to be supposed to depend on a single character.

Histology of Digestive Tract of simple Ascidians.*—M. L. Roule in this investigation has chiefly studied the Cynthiidæ; in the walls of their digestive tract he finds special tubular elements, which are very small (10 to 15 μ in diameter) and very numerous. They are absent from the œsophageal region, and are most often grouped around blood-spaces. Their wall is very simple, and consists of a single layer of epithelium, formed of small cubical cells, with a large nucleus; in their cavity there are more or less fine amorphous elements. Terminal dilatations are occasionally to be seen, and these bring to mind the renal capsules of Bowman. There appears to be a similarity in form and structure, as there is doubtless also in function, between these tubes and the renal organs of vertebrates; but it must be borne in mind that they have quite a different developmental history.

New Diplosoma.†—M. F. Lahille describes *Diplosoma Kœhleri*, a new species of Synascidian found at Guernsey and Roscoff, and gives some details as to its structure. The statement of Della Valle that fecundation in the Diplosomidæ is effected by the aid of a pore which opens to allow of the passage of the spermatozoa, and again closes, is shown to be incorrect.

γ. Brachiopoda.

Anatomy of Brachiopoda Inarticulata.‡—M. L. Joubin has chiefly studied *Crania*, which is found in abundance at Banyuls, and compares it with the other two known genera of this group, *Lingula* and *Discina*. The lower differs from the upper valve in the structure of the perforations, the disposition of the calcareous layers, the plexus of fine canaliculi, and by the calcareous incrustation of the layers of cartilage which are found in it. The mantle is formed of a delicate cartilaginous membrane covered on either side by a layer of cells; those which are applied against the shell form a kind of plexus whence arise tubes which invest the canals with which the shell is tunnelled.

* Comptes Rendus, cii. (1886) pp. 1503–6.
† Ibid., pp. 446–8.
‡ Arch. Zool. Expér. et Gén., iv. (1886) pp. 161–303 (9 pls.).

Folds of the mantle contain the organs of reproduction, and the margin is provided with muscular fibres; the mantle serves also as an organ of respiration. The lacunæ in the mantle which communicate with the general cavity are very simple in *Crania*, are more complicated in *Discina*, and form a true gill in *Lingula*. The arms given off from the body are free, and traversed by two canals, one of which sends off branches to the cirri; in the œsophageal region the two canals become very complicated and surround the digestive tube with a number of lacunæ; they here communicate with one another, and, by two small orifices, with the body-cavity. In addition to the two protractor and retractor muscles of the arms, an important bundle penetrates into their interior and ramifies in the cirri. The arms are formed of a thick resisting cartilage.

There are eleven muscles, the most important of which are the two pairs which occupy the four angles of the visceral mass, and serve as adductors and protractors of the shell. Four others fix the arms. The anus is in the axis of the body and slightly dorsal; the digestive tube has an extremely simple structure; the epithelium consists of a single row of long ciliated cells; the liver is also simply cellular, and is invested in a sheath of delicate cartilaginous tissue in *Crania;* but this is rudimentary in the two other genera.

There are no proper circulatory or respiratory organs, their functions being fulfilled by the perivisceral fluid and by other organs, especially the mantle. The sexes are separate, but there are no copulatory organs; the ovaries are thickenings of the epithelium of the general cavity, sustained by a kind of connective plexus.

The nervous system of *Crania* and *Discina* consists of a delicate circum-œsophageal collar; from the dorsal part, which is slightly swollen, and may be called cerebroid, the nerves to the arms are given off; they contain a very rich plexus formed of cells and nerve-fibres the subœsophageal portion supplies nerves to the mantle, viscera, and muscles.

On comparing the articulate with the inarticulate Brachiopoda we find that, while they are sharply distinguished, there are certain important characters, such as the cirri, lip, disposition of the nervous system, mesenteries and gonads, which present a number of common characters, variously developed in different families of either group.

The author agrees with Gegenbaur in regarding the Brachiopoda as a distinct group, but he does not seem to be aware of the opinion expressed by the distinguished anatomist some eight or nine years ago in his last text-book of Comparative Anatomy. In certain points of organization they exhibit resemblances to Acephala, Annelids, and especially Bryozoa; these are enumerated and discussed by the author.

Anatomy of Discina.*—M. L. Joubin has some notes on the anatomy of this rare Brachiopod. The mantle is delicate, and traversed radially by branched canals, which open by a large number of small orifices into a vast intra-pallial lacuna. The peduncle is a sort of oval sac, attached by its upper face to the mantle, and having the

* Comptes Rendus, ci. (1885) pp. 1170–1.

form of a sucker below. In it there are three vertical groups of muscles, and a circular muscle. The muscular apparatus is more like that of *Lingula* than of *Crania;* the digestive organs are more complicated than Owen thought: there is a vast ovoid stomach and a large liver. The central nervous system, though reduced, is more easy to make out than that of *Lingula* or *Crania*. The genital organs form two distinct groups, attached to the gastro-parietal and ileo-parietal membranes; the gonads are large, and their branches are attached to an arborescent skeleton of connective tissue. The oviducts are formed by a pair of pleated funnels attached to the body-wall and to the ileo-parietal membrane; they are continued forwards by a long canal which is placed between the anterior adductors and the body-wall, and they open not far from the base of the arms.

Structure of Lingula pyramidata.*—Dr. H. G. Beyer has published an important memoir on this subject.

The structure of the shell has been described by Gratiolet, who rightly described it as being built up of alternating horny and calcareous layers: his "periostacum," however, is replaced by the name "cuticle"; this is continued over the whole surface of the shells and the peduncle; it remains unstained by borax-carmine, but is stained variously by other agents. Just below the cuticle, as also in other parts of the shell, are clusters, here and there, of small round homogeneous corpuscles, which are regarded as homologous, and perhaps analogous, to those occurring in the septa, running vertically in the shell of Testicardinate Brachiopods. As the edge of the shell is approached, the alternating calcareous and horny layers decrease in thickness, and the horny layers are continued, below the epidermis of the peduncle, as a "supporting lamella," which is acted on by staining agents in exactly the same manner as are the horny layers. The cuticle is probably a changed larval integument, or has in some way been produced by it. The body-wall, mantle, and peduncle all have the same structure, and consist of an ectodermic epithelium, a supporting tissue, and a peritoneal epithelium; all shell regions contain prolongations of the body-cavity. The typical cuboidal character of the ectoderm varies in different regions of the body: sometimes being more than one layer in thickness, sometimes containing peculiar ovoid bodies, somewhat like taste-bulbs.

Immediately below the ectoderm the nervous system occurs in certain regions; as well as calcareous plates, which, when dissolved, leave "vacuoles" surrounded by a membrane, together with nucleated granular cells. The supporting lamella in those parts in which the nervous system is found contains spindle-shaped nucleated cells. In the peduncle and other regions, instead of a simple lamella of supporting tissue, this becomes a network, in the meshes of which are bundles of spermatozoa. The bundles of fibres which pass to the bases of "hair-follicles" near the margin of the mantle, and the "mesenteric bands," are not muscular, as has previously been stated to be the case, but are only bundles of this supporting tissue. All

* Stud. Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 227–60 (4 pls.).

the muscles in *Lingula* belong to the smooth variety, none are striated as in the Testicardinates. The "parietal muscle" of Hancock, as well as the "muscle" in the arms and peduncle, are not muscular, but "mesenchymatous supporting substance, possessing perhaps a certain amount of elasticity, but lacking contractility."

As to the vascular system, the author agrees with Shipley, Schulgin, and Morse, that the older writers were wrong in their description of a "heart": no such pulsating organ can be found in *Lingula*. Four different kinds of corpuscles are found in the fluid of the cœlom and its connections: (*a*) small round granular corpuscles, regarded as young ova; (*b*) spindle-shaped, striated spermatophores; (*c*) the corpuscles found below the cuticle of the shell and elsewhere; (*d*) blood-corpuscles proper, which are round bodies, with homogeneous protoplasm and a small nucleus. The alimentary canal is lined by a ciliated epithelium surrounded by a thick layer of very small cells, in which, near the circum-œsophageal nerve commissure are large apolar ganglion-cells; outside this layer is a layer of supporting tissue. From the stomach several regularly arranged branching cæca are given off: these are "liver lobules"; the wall of each consists of a thin layer of supporting substance with peritoneal epithelium, within which is a single layer or several layers of rounded granulated nucleated cells surrounding a lumen.

The nervous system agrees with that of *Waldheimia* as described by Hancock, rather than with the descriptions by other authors, which Dr. Beyer quotes. There are five ganglia round the œsophagus: a "great central subœsophageal ganglion"; two "ventro-lateral"; and two "supra-œsophageal ganglia: these last are smaller than the others. The two ventro-lateral ganglia are connected with one another by a commissure; each is also connected with the subœsophageal ganglion, and to the supra-œsophageal ganglion of its side. This last commissure forms the circum-œsophageal commissure, which gives off pallial nerves, and passes along the base of the arms, which are themselves supplied by nerves from the supra-œsophageal ganglia. The author is not certain as to the existence of certain "sensory cells" in the ectoderm described by Schulgin.

The genital apparatus consists of the genital glands and the "segmental organs" or genital ducts; these are the structures which were, by the older writers, regarded as "hearts." While the majority of authors, both ancient and recent, have regarded Brachiopods as diœcious, the present author feels no doubt that *Lingula* is hermaphrodite, as he found both ova and spermatozoa in the same animal, though both elements were not equally developed at the same time. The genital glands occur in the mantle, and the arrangement of the ovary is nearly the same as that in *Waldheimia*, as described by Hancock; the genital elements are derived from the cœlomic epithelium, and are seen in the meshes of the supporting substance of the mantle; but in the visceral chamber the ovaries are confined to the mesenteric bands, while the spermatozoa occupy the peripheral walls of the cavity. The "segmental organ" or "oviduct" has been accurately described by previous writers. It appears to function

as sperm-duct at one time, when its internal aperture is closely applied to the body-wall, but when it carries ova to the exterior this aperture is directed backwards to the posterior portion of the cœlom, so that the duct is in some way movable.

The author finds that picric acid is the best hardening agent for *Lingula*, followed by picro- or borax-carmine as staining agents, osmic-acetic acid being also a useful agent.

Arthropoda.

Claus on the Classification of the Arthropoda.*—Prof. C. Claus answers the article of Prof. Ray Lankester,† and points out how his proposed system differs from that of the English naturalist, and that much of his system has been expressed in earlier papers and in his text-books. Some of the results of Lankester's investigation of *Limulus*, as well as his hypotheses, are criticized. To this Prof. Lankester rejoins,‡ maintaining his original position.

a. Insecta.

Origin of Cellular Elements of Ovaries of Insects.§—Dr. E. Korschelt has a further essay on this subject, which owes its origin to his having found that some of his earlier results were due to the unsatisfactory condition of his preparations. He now states that, as Will has asserted, the germinal vesicles arise from the nuclei which are collected in large quantities at the base of the terminal chamber of the ovary. The new results were obtained by the use of double coloration with picrocarmine and hæmatoxylin, when the germinal vesicles become red, and the other nuclei of a dark violet colour. It may be concluded that the cellular elements of the ovaries of insects arise in various ways, while the epithelium has always much the same mode of origin. In all the forms examined by the author the nuclei of the terminal filament and the indifferent elements at the tip of the terminal chamber may be followed as far as the epithelium of the true oviduct, without undergoing any remarkable change.

With the ovarian and nutrient cells it is different; in the Orthoptera and in those Coleoptera in which there are several nutrient chambers the conversion of the indifferent elements into germinal cells takes place at the tip of the terminal chambers; in Coleoptera without several chambers and in the Hemiptera the germinal vesicles appear to arise from small nuclei at the base of the terminal chamber.

Origin of Colours in Insects.‖—Mr. J. W. Slater adduces some evidence to disprove Mr. Grant Allen's theory that the most beautiful insects are such as haunt flowers, fruits, &c., and that carrion feeders are, on account of their food material, the most ugly, or dull coloured. The author mentions various species from the different

* Ann. and Mag. Nat. Hist., xviii. (1886) pp. 55–65.
† See this Journal, *ante*, p. 419.
‡ Ann. and Mag. Nat. Hist., xviii. (1886) pp. 179–82.
§ Zool. Anzeig., ix. (1886) pp. 256–63.
‖ Trans. Entomol. Soc. Lond., 1886, pp. xix.-xxiii.

orders of insects, and from them concludes, that (1) carnivorous insects are not inferior in beauty to those which feed on flowers, &c.; and (2) that the flower and fruit eating group contains amongst them numerous dull-coloured species.

Development of the Bee.*—In studying the eggs, Prof. B. Grassi traced the external features by examination in the fresh state; for sections, the eggs were hardened either in hot water at a temperature of 70° C. or in picric acid; they were then treated with alcohol and stained with picrocarmine. The egg is an ovoid cylinder, rounded at each end; at the larger (anterior) end is placed the micropyle; one face, the future ventral surface, is convex; the other concave. The chorion, which closely surrounds the egg, in spite of its thinness, is very tough, and prevents the action of reagents upon the protoplasm; and as it cannot be removed without injuring the egg, it was found best to pierce it in various places in different eggs. The embryo, when formed, is not coiled within the egg-shell, but is of the same length as the egg.

The vitelline membrane described by Bütschli was not found. At the end of each paragraph the author refers to and discusses the results of previous authors.

I. *Special part:* (*a*) *formation of blastoderm.*—No polar bodies nor amœboid nuclei were observed; the egg consists of vitellus, in which no nucleus is visible; soon a space appears at each end of the egg; and at the anterior pole, two cells are seen. These are followed by four cells and so on—all remaining united, and giving rise to a blastoderm, which extends all round the vitellus; the cells forming it being smaller on the future ventral than on the dorsal surface. The cells on this latter surface are large and multinucleate, and separate from one another, but they soon disappear, apparently by shrinking of the blastoderm, so as to leave the vitellus, which consists of oily globules, uncovered over a certain area.

b. Amnion.—The cells of the ventral surface of the blastoderm are small, whilst those at the sides are larger; the former set gives rise to the ventral plate; the latter becomes the amnion. There first forms a space at each end of the vitellus; the walls of the spaces are partly formed by the amnion, partly by the ventral plate.

During the formation of the germinal layer the edges of the amnion meet over the embryo and coalesce, so as to form a covering containing liquid; this amnion is only one cell thick, and is probably derived from the cells from the dorsal surface of the blastoderm; no new cells emigrate from the yolk to form it.

c. The germinal layers—Along the greater extent of the ventral plate there appear two longitudinal, undulating grooves, one on each side of the median line. The middle portion between them becomes nipped off, so as to form meso-entoderm, whilst the lateral portions then grow over the depressed area and unite, leaving no trace of their union; this forms the ectoderm.

The process commences anteriorly and gradually extends back-

* Arch. Ital. Biol., vii. (1886) pp. 242–73.

wards. Anteriorly and posteriorly, however, a slightly different mode of formation of the mesoderm obtains. At the two ends the longitudinal grooves are absent, and the ventral plate here becomes thickened and stratified along the middle line; then the superficial layer (ectoderm) becomes separated from the deeper layer (mesoderm). The latter, which is continuous with the central portion of mesoderm, gradually grows round so as to occupy the space which has appeared in the vitellus; here it is gradually folded on to the dorsal surface, the sides progressing more rapidly than the median portion. As it grows backwards, the thickness diminishes, and at the edge consists only of a single layer of cells, which the author regards as the most anterior portion of endoderm; which is thus derived from the mesoderm, and pushes its way between the yolk and the ectoderm. It is difficult to say where the mesoderm commences to become endoderm. The anterior and posterior portions of endoderm approach and ultimately meet together.

Meanwhile, the embryo is becoming shorter, as the ventral plate curves more and more to the dorsal surface.

The derivation of the endoderm from mesoderm is contrary to the opinion of Balfour, Dohrn, &c., who regarded it as formed from certain cells remaining in the yolk. Prof. Grassi denies that any such "secondary segmentation" of the yolk takes place, although protoplasm with nuclei in it forms a syncytium in the yolk, and in a later stage this gives rise to the granular material which fills the mesenteron. Moreover, these cells are never in rows, so as to give rise to any membrane.

d. The nervous system.—The cerebral ganglia are formed as two thickenings of the ectoderm, which do not become united till late in development. The fossa observed by Hatschek in lepidopterous embryos, appears after the ganglia are detached from the ectoderm. The ventral chain arises as two longitudinal swellings, which are at first quite separate; the whole thickness of the ectoderm is concerned in the formation, which sinks, and the ectoderm grows over the chain. The transverse commissures appear, from ectoderm, later on.

e. Tracheal system.—The ten pairs of stigmata are the first to appear, before the limbs show themselves, and after the amnion is a complete sac. The anterior ones appear first; and they are all formed on the latero-ventral line, before there are any signs of segmentation. The inpushed ectoderm, which gives rise to the stigma, grows in, divides into an anterior and a posterior branch, which push their way in between ectoderm and mesoderm. The lateral tracheal trunk is united to its fellow of the other side above the œsophagus and above the rectum. The "spiral filament" appears later on. Up to the time of hatching the tracheæ are filled with the amniotic liquid.

f. Alimentary tract.—The stomodæum makes its appearance simultaneously with the tracheæ; the proctodæum a little later. The former has a pit just behind the procephalic prominence. This pit deepens, as the yolk recedes, and enlarges at its inner end to form the gizzard. In the posterior region of the dorsal surface, two pairs of little pits become formed, which will give rise to the four

Malpighian tubules; then the area bounded by them becomes depressed, and will give rise to the rectum.

g. Silk-glands, &c.—A little behind the point where the second maxillæ will be formed, two fossæ appear, which are directed backwards, and ultimately extend through nearly the whole extent of the body; these are the silk-glands, and the two pores later on unite to form a single median opening. The salivary glands are formed as ectodermic invaginations just in front of the mandibles; each divides into a longitudinal and a transverse branch. The two transverse branches unite. A third pair of pits appear between the first and second maxillæ, but they soon disappear.

h. Cœlom.—As the stomodæum increases in length the yolk disappears before it, and leaves a space filled with liquid, partly occupied by the œsophagus and mesoderm. The posterior portion of the yolk behaves in the same way, and the yolk becomes concentrated round the future stomach or mesenteron. The mesoderm then divides into two layers, which are in contact dorsally, but separate elsewhere. No segmentation of the cœlom was observed, such as is described by Tichomiroff.

i. Dorsal vessel.—Along the line where the two layers of mesoderm meet dorsally, the dorsal vessel is formed; corpuscles appear before the proper walls are formed; they arise from mesoderm, and not, as Dohrn has described, from the yolk.

k. Genital organs.—Two solid cords of cells, without connection with one another, extend from the fourth to the eighth abdominal segment; these are placed at the junction of the two mesodermic layers, outside the dorsal vessel, and give rise to the genital organs.

l. Lining of the middle intestine.—The stomach or mesenteron is lined entirely by entoderm, which has already been described as at first forming a roof to an internal cavity; the sides bend round, and meet on the ventral surface to form a tube.

m. Appendages, &c.—The procephalic lobe appears as an unpaired projection of ectoderm and mesoderm at the anterior extremity; it, later on, bends downwards so as to form the upper lip.

The antennæ appear simultaneously with the buccal appendages: of the latter there are four pairs, of which the first pair totally disappears; while the rest form the mandibles and the two pairs of maxillæ. The thoracic appendages arise one after the other.

The abdomen, as a rule, carries no appendage; but in one or two instances Prof. Grassi saw paired processes on the last segment, and on that carrying the tenth pair of stigmata; these soon, however, disappeared.

Bütschli appears to have mistaken the prominences formed by the deep intersegmental grooves for rudimental abdominal appendages.

II. *General part.*—The development of the bee may serve as a type, up to a certain point, of the development of insects generally, although the Hymenoptera seem to be the highest of the insects, and the bees the most advanced of this order.

a. Formation of the blastoderm.—The segmentation of the egg is very similar in the bee to that observed by Bütschli in the Lepidoptera,

and by Weissmann in the Orthoptera; while that of *Cynips*, one of the Hymenoptera, is different from these. Here the vitellus shows in the centre numerous nuclei, which emigrate to the surface, draw the protoplasm around them, and form the first cells of the blastoderm. Among the Diptera, *Chironomus* shows free nuclei in the centre of the yolk, although a protoplasmic layer has already appeared on the surface.

Grassi's observations agree with those of Bobretsky and Tichomiroff, in that, in the blastoderm, cells with numerous nuclei are seen—a sign of endogenous division. This has led him to describe the segmentation as follows:—"The segmented egg is only a very large cell with numerous nuclei surrounded by protoplasm in which is imbedded a great quantity of deutoplasm." He asks, "Why is the blastoderm formed on the surface instead of elsewhere? What is the explanation of centrolecithal ova?" He explains it from a physiological point of view. The cells are, in this position, in close contact with the external medium on the one hand, serving therefore for respiration and excretion; whilst their contact with the yolk within supplies them with nutriment. In a similar sort of way he would explain other modes of segmentation. He mentions casually that in none of the numerous eggs which he has examined fresh and by sections has he ever seen caryolytic figures.

b. Formation of germinal layers.—He aims at showing that the mode of formation of the layers in insects takes place by a process of gastrulation, directly comparable to that in *Peripatus*, and that it does not differ fundamentally from the process in other Metazoa.

The median groove, by means of which the ento-mesoderm is formed in the silkworm, may remain as a canal for some time. In the bee this groove is replaced by a pair of grooves. Contrary to what occurs in ordinary gastrulation, the entoderm is derived from the mesoderm; hence, to reduce the difference, he speaks of a "meso-entoderm."

c. Analogy of amnion.—The author considers the amnion, as found in existing insects, as forming an integral part of the embryo's body in former times. He starts by supposing it to have been part of the dorsal wall of an ancestral insect, and taking no share in protecting the embryo (just as is found in the lowest Articulata). The dorsal wall grew more rapidly than the ventral plate, and became folded over the embryo, and served to protect it; later on in development, however, it became filled out, and formed merely part of the body.

Gradually it would take a greater and greater share in protection, and cease to be a part of the body. Although analogous with, yet he shows that it is not homologous with the vertebrate amnion.

d. Homology of Malpighian tubes, &c., with stigmata.—The absence of stigmata on the two last segments of the body is compensated for by the presence of a pair of Malpighian tubes in each of these segments. In all insects the mode of formation of these two structures agrees. The Malpighian tubes are, indeed, nearer the middle line, but if the abdomen were not folded on to the dorsal surface of the

egg, the apertures of these two series of structures would exactly correspond.

In the silkworm the stigmata are absent on the last three segments, and there are three pairs of Malpighian tubes.

There are three pairs of ectodermic pits, corresponding to the three buccal segments; and although their position differs from that of the stigmata, Grassi considers these salivary and spinning glands to be homologous with tracheæ. All the above-mentioned organs are, whilst in the egg, filled with the amniotic liquid, and the author considers that they are all excretory organs during development within the egg.

Palmén and Gegenbaur have suggested that the tracheæ were originally excretory organs, and only secondarily became respiratory. If it could be shown that the antennary glands and other presumably excretory organs in Crustacea, and the nephridia in worms, are all ectodermic in origin, there would be an homology between all these organs.

e. Circulatory system.—The hypothesis of Bütschli that the vessels are the remnants of the segmentation cavity may well be true, if the space between ectoderm and endoderm, and the mesoderm (due to the withdrawal of the yolk), and from which the dorsal vessel is formed, is to be considered as a segmentation cavity.

f. Appendages.—The first pair of buccal appendages, which almost immediately disappears, may perhaps be the homologue of the second pair of crustacean antennæ.

The disappearance of certain appendages proves that the larvæ of the ancestors of the bee lived a free life, and resembled the genus *Campodea*. This supports the theory that the latter are to be considered as *proto-insects*.

Luminous Organs of the Mexican Cucuyos.*—Herr C. Heinemann communicates a detailed account of his researches on the anatomy and physiology of the luminous organs of certain Mexican Pyrophori, or Cucuyos.

a. Macroscopic.—The organs in question consist (1) of two elliptical patches on the upper surface of the prothorax, and (2) of a ventral organ on the first ventral ring of the abdomen. Their more exact position is carefully defined. They are known to be special differentiations of the dermal matrix—the so-called hypodermis. Even with the naked eye, two layers are distinguishable, an external luminous stratum, wax-like in the daytime, and a non-luminous, white, lower layer.

b. The respiratory system.—After describing the disposition of the tracheæ, Herr Heinemann seeks to establish from his observations the following statements:—(1) The inspiration occurs passively, but the exspiration is effected by the contraction of the muscles connecting the rings of the body; (2) the respiratory movements of the beetles are restricted to the abdomen; (3) the movements are continued as usual, even after the removal of the head and prothorax, so that the innervating centre cannot be exclusively sought in the œsophageal or in the prothoracic ganglion.

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 296–382.

c. The finer structure of the luminous organs.—The histology of the two layers is next described. The appearance of the luminous cells in their living and dead form, the occurrence of the yellowish-green pigment, formed during the luminous process, the acid reaction of the layer, the effect of various reagents, the relation of the tracheæ to the luminous organ, &c., are intimately discussed. (2) The non-luminous layer consists of tracheæ and loosely packed irregular masses, and is not definitely separable from the luminous stratum above. The masses consist of urates, probably with potassium and calcium bases. A well-developed layer of muscles, below the luminous organ, doubtless serves to force the air from the larger tracheal stems into the finer branches, and thus aids in the luminous process.

d. The phenomena of the luminous function.—Herr Heinemann describes the phenomena of the luminous process both in the living and dead beetle, noting the colour, intensity, and spectroscopic relations, the variations under different circumstances of flight, sleep, time of day, &c. He distinguishes the soft light seen on the sleeping animal or on excised portions, from the blaze exhibited during active respiration. His study of the relations of the organs to the respiratory system leads him to explain the variations of light by reference to the distribution, &c., of the tracheæ. The light is brightest and lasts longest in those portions which are nearest to tracheal branches of considerable calibre. He shows that the tracheal system of the posterior organ is quite independent of the thoracic, since inspiration through the latter does not excite luminous function. Nor is there any communication between the tracheæ of the luminous organ and those of the rest of the posterior portion of the body. By a similar reference to the tracheal system, he explains the differences between the luminous function of the Pyrophori and that of the Lampyridæ. In criticizing Max Schultze's emphasis on the rôle played by the terminal tracheal cells, he notes—(1) that the luminous organs of the Cucuyos are wholly destitute of tracheal terminal cells; (2) that the luminous cells are only browned and never blackened by osmic acid, which does not harmonize with the connection between luminosity and blackening by osmic acid, which M. Schultze sought to demonstrate in regard to the Lampyridæ; (3) that the non-luminous layer, on the other hand, behaves to osmic acid exactly as the tracheal terminal cells of the Lampyridæ, and (4) that the "punctate" appearance of light, which Schultze explained by referring it to the tracheal terminal cells, is really explicable in terms of tracheal distribution. The luminosity of excised portions, which may in a damp chamber remain functional for two or three days, is then discussed.

e. The influence of the nervous system on the evolution of light.—As the result of a number of crucial experiments effected by cutting the nerves at various places, the author has demonstrated that the luminous function of the ventral organ is exclusively influenced by the respiratory movements, and therefore only indirectly excited through the central nervous system. No excitation of the ventral cord resulted in luminous function. There are no special luminous

nerves. He shows *inter alia* that the ventral organ, or rather the abdominal respiratory movements are controlled from two centres, the metathoracic and the cephalic ganglia. The excitation of the thoracic organs is less satisfactorily investigated, but here again it seems most probable that there are no special luminous nerves, and that the organs are exclusively influenced by muscular contractions. A corroboratory experiment in which the luminosity was excited by blowing in air, beautifully confirmed the above results.

f. The effect of artificial stimuli.—The blaze of light results solely from the oxygen expressed from the tracheæ; mechanical, chemical, and electrical stimuli (on excised organs of course) only effect the lesser light already referred to. Mechanical irritation was most effective, though some chemical reagents gave an approximate result. For the results of the thirty or so chemical reagents, and of the immense number of electrical experiments (conducted under great difficulties of deficient apparatus), it is only possible here to refer to the summary given in the memoir (pp. 369–377).

g. The nature of the luminous process.—Beyond the fact that the luminous function depends on an oxidation process, hardly any certain statement can be made. During luminosity a greenish-yellow pigment seems to be formed, but the import of the observation is not yet determined. Herr Heinemann expresses his opinion that the protoplasm of the luminous cells forms a definite substance, luminous in contact with oxygen. The organs are probably peculiarly modified skin-glands, and the formation of this specific substance is comparable to the activity of glandular cells. What the substance is Herr Heinemann hopes to discover by further research. He was hindered from following up its resemblance to white phosphorus, by the impossibility of obtaining even a fragment of phosphorus in Laguna de Terminos!

Glands of Insects—A new type of Elastic Tissue.*—M. J. Gazagnaire states that the so-called elastic cells described by M. Viallanes in *Eristalis* as a new type of elastic tissue are merely unicellular glands, which have a lubricating function.

Nature and Origin of the Spiral Thread in Tracheæ.†—Weissman has described the origin of the "intima" and of the spiral thread of tracheæ in insects, and has shown that the peritoneal membrane of the trachea is the inpushed epiblast, while the "intima" is merely a sort of cuticular product of this peritoneal epithelium. Dr. A. S. Packard gives the name "endotrachea" to this cuticle, and "ectotrachea" to the epithelium which produces it. By the study of transverse sections through the pupa of *Datana* sp., he concludes that the so-called spiral thread is not really spiral, but is a series of circular thickenings of the endotrachea; these thickenings or "tænidia" may extend all round, or they may, as at the branchings of a trachea, only partly surround the tube.

* Comptes Rendus, cii. (1886) pp. 1501–3.
† Amer. Natural., xx. (1886) pp. 438–42 (3 figs.).

In a subsequent note* the author remarks that in some insects the thread may be a continuous spiral; which he speaks of as a "tænidium," using the plural when the thread is not continuous.

In the development of these structures the author finds that the ectotrachea appears as a layer of nuclei which send off processes, having a more internal position and running round the lumen; it is from these prolongations that the tænidia will be formed and by their growth and fusion give rise to the endotrachea, of which the tænidia are only band-like thickenings, each being independent and usually ring-like; but where a trachea branches, a new series of tænidia commence.

Odoriferous Organs of Bed-bug.†—M. J. Künckel is of opinion that the observations of Landois on the odoriferous organs of the bed-bug are incomplete and inexact. Young specimens, on leaving the egg, have three odoriferous glands in the dorsal region of the abdomen; to see these glands, the insects must not be studied when their digestive tract is gorged with blood, but they must be first made transparent. These three glands remain till after the last ecdysis, when they are replaced by thoracic and sternal glands. The author points out that there are two systems of glands in those Hemiptera which have not been so modified as to lose their wings. The presence of the metathoracic sternal apparatus may be taken as a criterion of maturity.

Internal Air of Insects compared with that of Leaves.‡—M. J. Peyron gives the results of his experiments as to the percentage of oxygen contained in the air within insects.

He kept 100 grams of cockchafers in a covered dish and drew off the air each day; in some cases at the temperature of the laboratory, at others when heated in the sun, again when surrounded by ice. From these experiments he concludes that as the vitality of the insects decreases, as by cold, the percentage of oxygen increases, thus agreeing with the results of his experiments on leaves, and justifying his idea that "the proportion of oxygen increases when protoplasmic activity diminishes."

γ. Prototracheata.

Development of Peripatus.§—Herr J. Kennell has published the second part of his essay on the development of *Peripatus edwardsii* and *P. torquatus*.

The general form of the body and its changes are first considered. The circular markings on the appendages are stated to be nothing more than folds of the epidermis, in the formation of which no share is taken by cutis, connective tissue, or musculature. Segmentation affects the ectoderm, and all the ventral organs remain segmentally

* Amer. Natural., xx. (1886) p. 558.
† Comptes Rendus, ciii. (1886) pp. 81–3.
‡ Ibid., cii. (1886) pp. 1339–41.
§ Arbeit. Zool.-Zoot. Inst. Würzburg, viii. (1886) pp. 1–93 (6 pls.).

connected with the nervous system. The author makes additions to our knowledge of the metamorphoses of the cephalic end of the body.

In describing the development of the organs, the ectodermal structures are first dealt with; the nervous system, the ventral organs, and the slime-glands are especially noticed. The eye is developed very simply and has only a secondary connection with the brain. Of the mesodermal structures the first to be described are the segmental cavities; the primitive cavity becomes divided into three parts, which communicate with one another, and one of them becomes the infundibulum of the segmental organ. The paired segmental organ of the segment which carries the slime-papillæ undergoes the most remarkable changes, for it becomes converted into the salivary gland. This change occurs only at a late period. The existence of its segmental funnel seems to have escaped the notice of earlier observers. The generative organs appear to be nothing else than modified segmental organs; the author gives a very detailed description of their development, and points out that the ovary is the homologue of the testis, the receptaculum seminis and receptaculum ovorum of the vas efferens, the uterus of the seminal vesicle and vas deferens, and the vagina of the spermatophoral region and the ductus ejaculatorius.

The author concludes with some remarks and criticisms of the work of other naturalists who have studied *Peripatus*.

δ. Arachnida.

Brain of the Scorpion.*—M. G. Saint-Rémy finds that the brain of the scorpion is formed by a central mass of medullary substance, which above, in front, and partly at the sides, is invested by cellular layers. Towards the mid-third of its height the medullary substance forms the greater part of the mass; superiorly the medullary substance occupies only a part of the anterior surfaces, and the distinction into two halves is better marked. More than two-thirds of the supra-œsophageal mass represents the optic ganglion, and from it are given off two pairs of optic nerves. In the lower third of the brain the median groove grows shallower and shallower. At the plane of passage of the œsophagus the lateral cellular investment is, on its externo-lateral surface, continuous with the corresponding commissure. Recent researches have shown that in spiders this portion represents the original ganglia of the cheliceræ; in the adult scorpion the common ganglion of the cheliceræ commences a little below the passage of the œsophagus. It gives rise to the two paired nerves of the cheliceræ, and to an unpaired median nerve. The nerve-centres are enveloped in an external neurilemma provided with flattened nuclei, and in an internal neurilemma; fine fibres unite these two and form branches in the intermediate space.

* Comptes Rendus, cii. (1886) pp. 1192–4.

ε. Crustacea.

Physiology of Nervous System of Lobster.* — Mr. C. F Marshall finds that there are no motor or sensory roots in the lobster analogous to those of the spinal nerves of vertebrates; though there is no marked decussation of the nerve-fibres in the central nervous system, nervous impulses readily travel across the ganglion; each ganglion is a reflex centre for the appendages which it supplies. There is a distinct sense of touch which can be exercised through the thick cuticle in all parts, especially in the large claws. The cerebrum is the seat of origin of inhibitory impulses and, consequently reflex actions are much more marked when this mass is separated from the rest of the nervous system. All the ganglia are sensitive, i. e. respond to stimulation. Normally nervous impulses pass down the cord, but if this path be interrupted, they will pass up it.

Germinal Vesicle of Siphonostoma diplochoetos.†—M. E. Jourdan describes the ova of *Siphonostoma* as measuring 130 μ, while the germinal vesicle is 50 μ in diameter; the latter contains all the constituent parts of a cell-nucleus; its nucleolus varies in form and appearance, and appears to be altogether independent of the nucleus itself. The principal nucleolus appears to be capable of producing even when the ovum is in a state of repose, a certain number of grains of a chromatic substance; these detach themselves and migrate into the substance of the nucleus to give rise to secondary nucleoli.‡

Influence of Rhizocephala on the External Sexual Characters of their Host.§—M. A. Giard gives on account of the influence of *Sacculina Fraissei* on its host (*Stenorhynchus phalangium*). This new species is entirely hidden in the cavity formed by the tail of the crab and its sternal plastron; its characters are described, and it is stated to be allied to *S. corculum*. Its female hosts have the four pairs of ovigerous legs greatly reduced, and the males have much shorter copulatory stylets. The secondary sexual characters of the male are also affected, for the chelæ do not extend beyond the head, as they do in normal males. M. Giard thinks that a comparable set of facts are only to be found in castrated vertebrates. Other parts of Sacculinids may be found, on examination, to have the distinctive sexual characters reduced and rendered less well marked.

Nervous System of Peltogaster.‖—M. Y. Delage says that, having obtained nearly 2000 examples of *Pagurus*, he found that of 1651, 48 (or 1 in 35) were effected by the parasite *Peltogaster;* if medium sized specimens alone are taken, 1 in 20 is found to be infested.

Describing first the general arrangement of the organs, the author

* Studies from the Biological Laboratories of the Owens College, i. (1886) pp. 313-23.

† Comptes Rendus, cii. (1886) pp. 1494-6.

‡ "Molécules secondaires" is apparently a misprint for "nucléoles secondaires."

§ Comptes Rendus, ciii. (1886) pp. 84-6.

‖ Arch. Zool. Expér. et Gen., iv. (1886) pp. 17-36 (1 pl.).

reminds us that *Peltogaster* is curved on itself, that it is fixed to its host by a small pedicle, which varies a little in position and has at the other end the cloacal orifice.

It is of a rosy colour, but becomes a reddish-orange when, as is often the case, it is full of ova. It is from 2 or 3 to 12 or 15 mm. in size. It has a very marked general resemblance to a *Sacculina*, but differs in some important points. The mesentery is not flattened, but very wide; the two membranous folds of which it is formed are not closely appressed, but separated by a mesenteric canal. The testes are a little nearer the pedicle, and their cæcal termination is not swollen but gradually tapers and loses itself in the adjoining connective tissue; their deferential orifice is much larger than that of *Sacculina*. The cement-glands are not, as Kossmann thought, absent, but are really very large. The ganglion which forms the sole representative of the central nervous system, is situated in the mesentery, in the sagittal plane between the pedicle and the cloaca, but is much nearer the former. The ganglion is so small and the surrounding connective tissue is so like it that it is almost impossible to make it out in a fresh specimen.

Specimens should be macerated in a 12 per cent. solution of nitric acid for three or four days, when they are relatively easy to dissect; the connective tissue is thus rendered very fragile, and is partially destroyed, the albuminoid substance of the ova is coagulated, and the ova formed into a solid mass which can be easily removed; the ganglion and nerves become tinged and much easier to see.

The ganglion is a small fusiform elongated mass, about 1 mm. in size and branched at its end; it is imbedded in connective tissue. It gives off three groups of nerves: an anterior, which contains four pairs; a lateral, in which there is only one pair; and a posterior, formed by a single unpaired nerve and its ramifications. In the median line the first group gives off a pair of very fine and long nerves, which extend along the mesentery, in the midst of the connective tissue, as far as the cloaca; they penetrate into the muscular substance into which they can be traced for a certain distance; they evidently terminate in the muscles of the cloaca, and especially in the sphincter; and they may be called the cloacal nerves. At the sides there are the paired anterior and lateral pallial nerves; the ovarian are given off from the anterior extremity of the ganglion, and are exceedingly delicate. The lateral group forms the parieto-visceral of either side, and its chief branch is the nerve of the cement-gland. The posterior group contains a large trunk which may be called the pallio-visceral nerve; this, near its origin, gives off a pair of very fine branches which supply the testes and their deferent canal. The author gives a brief notice of the histology of the nerve-fibres and cells.

The mantle of *Peltogaster* is formed, as in *Sacculina*, of nucleated epithelio-connective fibres, among which is a plexus of muscular fibres; the ovary, as in the allied form, consists of two lobes, and the testes of two tubes. The cement-glands are very large, and differ in position and constitution from those of *Sacculina*; the difference in position is due to the ovary opening at the level of the incubatory

pouch; the branched portion of the gland of *Sacculina* is absent. The author concludes with the reflection that his investigation of the nervous system has been rendered easy, not by special address in dissection, but because of the morphological knowledge which he had gained from the study of *Sacculina*.

Vermes.

Differentiating Embryonic Tissues.*—Dr. C. O. Whitman finds that each of the germ-bands in the developing egg of *Clepsine* is made up of three distinct layers; (1) an epidermal layer; (2) a layer, consisting of four longitudinal rows of cells; (3) a deeper layer, next the yolk, composed of longer cells. The layer (2) is the product of the four larger cells, "neuroblasts," at the posterior end of each germ-band. The third layer is derived from a large "mesoblast," which lies below the preceding.

The author confirms his previous statement that the nerve-cord is formed from the neuroblasts, but finds that only one row on each side, nearest the median line, takes part in its formation. These are stained a faint brown by osmic acid. (The author's method has been already given.†) The outermost row on each side gives rise to muscular tissue, and the two rows between these, which are much more deeply coloured by osmic acid, develope into nephridia. The author is uncertain whether these rows of cells extend into the prostomium; but the cerebral ganglia and nerve-ring are formed from cells below the epidermis, and not from a thickening of epidermis. There is a thickening of the epidermis overlying the four subœsophageal ganglia, but this gives rise to glands, which serve later on to attach the embryo to the parent. These gland-cells are stained deeply. The epithelium of the alimentary tract, except stomodœum and proctodœum, is formed from free nuclei belonging to the three large blastomeres. The alimentary tract is formed from in front backwards.

The sense-organs on the lip arise as bulb-like thickenings of the epidermis; two pairs of these are present at the time of hatching, and before the eyes and segmented sense-organs appear. From their symmetrical arrangement, the author thinks that these sense-organs are primarily segmental.

The Rhabditidæ.‡—Dr. L. Oerley has published a monograph on these nematoid parasites in which their medical relations as well as their structure and natural history are considered; greater attention has been directed to these worms since 1879, when there was an epidemic on board the training ship 'Cornwall' in the Thames; this epidemic was thought to be due to *Rhabditis terricola*, but Dr. Oerley shows that that nematoid is a monogenous form which always leads a free life, and cannot exist in the digestive tract of mammals: the heterogenous forms—or those which lead a hermaphrodite and

* Amer. Natural., xix. (1885) pp. 1134–7. † See this Journal, *ante*, p. 155.

‡ 'Die Rhabditiden und ihre medicinische Bedeutung,' 8vo, Berlin, 1886, 84 pp. and 6 pls.

parasitic alternating with a dioecious and free life—as *Rhabdonema*, and *Angiostomum*, are now placed in the separate suborder of the Rhabditiformæ, and the family Rhabdonemidæ.

Excretory and nervous system of Duthiersia and Solenophorus.*—M. J. Poirier describes the *excretory system* of *D. expansa* and *S. megalocephalus* as consisting of two pairs of longitudinal vessels connected by a transverse vessel in each ring. The external vessels are more delicate than, and placed dorsally to, the internal vessels; the walls are not cellular, but are formed of a thickening of the connective tissue that surrounds them, and of a muscular coat. In the head the internal vessels are merely represented by a network of vessels; at some distance from the head a series of secondary vessels is met with; starting from this region the principal vessels give off a large number of branches. Some ramify a great deal and are especially numerous in the central region of the rings, where they terminate in funnels; others pass peripherally and unite to form a lacunar vessel, placed inside the nervous system.

The *nervous system* in the rings consists of two large longitudinal cords placed outside the excretory system. These pass into the head and pass along the wall of the sucker; at the anterior extremity each forms a ganglion, which are joined together by a transverse commissure. In *Duthiersia* the nerves in the head give off lateral nerves, and from each ganglion a couple of nerves are given off, each pair of nerves uniting to form a ring. The other lateral nerves form a network, which lies close below the sucker. In *Solenophorus*, the nerves in the head give off no lateral branches, and each of the lateral nerves from the two ganglia has itself a ganglion upon it; the two nerves unite to form a ring as before; this nerve-ring lies just below the muscular ring of the sucker. The difference exhibited by the nervous system in these two genera is probably connected with the different mode of fixation to the host found in each. In *Duthiersia* the villi of the intestine are compressed by the whole surface of the sucker, whereas in *Solenophorus* the villi are clasped only by the muscular rim of the sucker.

Parasites of Malapterurus.†—Prof. G. Fritsch describes various helminth-parasites from this electric fish. *Corallobothrium* is a new genus of Cestoda, which appears to be intermediate between the Bothriocephalidæ and the Tæniidæ. It has a terminal cavity in which there are four suckers arranged crosswise; no neck; and typical gonads with marginal orifices. The form of the head is very like that of *Caryophyllæus*. The sole species known is called *C. solidum*. There is also a new *Tænia* which is called *T. malapteruri*. Of the Nematoids, *Trichosomum papillosum* sp. n. was found in the stomach, and even in young examples of the fish there were specimens of *Filaria piscium*, which were encapsuled in the body-cavity, in the muscles, and even in the electric organ itself. The author justly

* Comptes Rendus, cii. (1886) pp. 700–3.
† SB. K. Preuss. Akad. Berlin, 1886, pp. 99–108 (1 pl.).

remarks on the extraordinary character of the last-named site, where the parasites must be exposed to the full force of the electric shock.

Studies on Rhabdocœl Turbellarians.*—In his first contribution Dr. L. Böhmig deals with the genus *Graffilla*, first described by v. Ihering in 1876. After some account of the external form the author describes his methods of study. The worms were treated with hot and cold solutions of corrosive sublimate, 1/2–2 per cent. solutions of chromic acid, Kleinenberg's picric acid solution, and 1 per cent. osmic acid. The first gave the best results. For museum purposes they are best killed with picric acid.

The author gives a detailed account of the organs, even of parts that have been already correctly described by previous observers.

Histology of Acœlous Rhabdocœla.†—M. Y. Delage finds, from a study of *Convoluta schultzii*, that the investment of the body is formed by a layer of ciliated cells, which have partly lost their individuality, and of the three most muscular layers. Within the body there are, in addition to the reproductive organs, a well-developed otocyst, two eye-spots, a frontal organ which has the function of tactile sensation, and is, possibly, also olfactory, a well-developed nervous system, and germ-cells. The whole of the free space is occupied by the reticulum, which is dense in the head, rarer in the superficial layers of the body, and still rarer in the central parts. It is, however, everywhere continuous, and there is no distinct digestive cavity. The nerves are invested in an endothelial sheath, formed of connective-tissue cells, which completely separate them from the other organs. With regard to the lacunæ in the reticulum the author desires to speak with some reserve. He believes that in *Convoluta*, at any rate, this reticulum represents a true connective tissue, and that it is not a continuous mass, hollowed out by vacuoles. He points out that all the space circumscribed by the integuments, and invaded by the reticulum, which occupies without filling it, represents the fused general and digestive cavities. If this be so, the reticulum is merely an unimportant supporting tissue, arranged so as to consolidate the organism, without forming any complete septa. Everything is found in a common cavity and bathed by common fluids. If, on the other hand, the reticulum forms a continuous and closed system, it establishes some kind of order. The lacunæ are closed, the food and the zoochlorellæ are separate from the nerves and the sexual products, and have their special modes of exit.

With regard to the small cells which Mr. Geddes has called *Pulsatella Convolutæ*, M. Delage states that they are caliciform, have no nucleus, and have their cavity occupied by a tuft of cilia which move rhythmically. This cavity does not appear to communicate with special ducts, or with the lacunæ of the reticulum. In favour of the view of Geddes that they are protozoic parasites, it is to be noted that they are not regularly distinguished through one animal, or equally through several. One *Convoluta* may have thirty or forty, and another

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 290-328 (2 pls.).
† Arch. Zool. Expér. et Gén., iv. (1886) pp. 109-60 (2 pls.).

only three or four. They are generally found in greatest numbers near the head, and especially near the mouth; but this is not always the case. Lastly, they do not appear to be injured by being expelled from the body, for their movements are then often twice as energetic. These reasons, however, do not appear to the author to be conclusive. Against them there is the fact that *Pulsatellæ* have never been found swimming freely in the water in which the *Convoluta* dwells. Another hypothesis is possible—that they are cells of the body of the animal which have projected into one of the cavities of the reticulum, and have become differentiated into a small organ capable of producing movements of the contained liquid. Their development, however, remains to be worked out. Analogy helps us so far that in *Gunda* Lang has discovered ciliated infundibulate cells mixed with those of the intestine, and has admitted the possibility of the analogous cells in the parenchyma being migrants from the intestinal layer. The question is one which can only be solved by a history of their development.

Cephalic Pits of Nemertines.*—M. Remy de Saint Loup thinks that the cephalic pits of the Nemertinea may be strictly compared to the essential forms of the segmental organ of the Hirudinea, from which they only vary in structure and function. They may serve as auditory organs, as an irrigating and respiratory apparatus, or as a head-kidney.

Ctenoplana Kowalevskii.†—Dr. A. Korotneff describes a remarkable new form which appears to be allied to *Cœloplana metschnikowii*. He found it at a small coral-islet, Pulu Pandau, off the west coast of Sumatra. Externally it is quite flat and round, and measures about 6 mm. in either direction. It creeps about like a planarian on its ventral surface, in the centre of which there is the rounded mouth. On the middle of the dorsal surface there is an otolith-vesicle; the line which joins this with the mouth may be regarded as the primary axis. In the middle of the anterior and of the posterior margin there is a notch, and the plane which unites them and passes through the primary axis may, in accordance with Chun's terminology of the Ctenophora, be called the gastric plane. Along this plane the animal folds itself when it sinks from the surface to the bottom of the water. In such a position one best sees a thickening of the surface, which extends backwards and forwards into two blunt points. Right and left there are three similar points, and they all give a stellate appearance to the thickening. Between these rays there are cleft-like orifices, which inclose ctenophoral plates, which are capable of protraction and retraction.

The transverse plane, and that at right angles to the gastric, inclose two tentacles, the presence of which can only be detected in sections. In colour, *Ctenoplana* is rosy above and yellowish below; the margin of the body is transparent.

As in *Cœloplana* the tentacles are solid, the lumen being occupied

* Comptes Rendus, cii. (1886) pp. 1576–8.

† Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 242–51 (1 pl.).

by longitudinal muscles. The mouth leads directly into a cavity, whence arise the gastro-vascular canals, or better, enteric branches; these are very numerous, and do not appear to be definitely arranged; they anastomose at their periphery. The inner gastric wall developes various internal processes; the epithelium is covered by a number of long cilia, and contains unicellular glands. The new form differs from *Coeloplana* in having one instead of two vertical canals; this, which lies centrally below the otolith-vesicle, appears to correspond to a funnel of the Ctenophora, which is here considerably reduced, and is not an independent structure, but an integral part of the gastric cavity. Dorsally there are right and left, two small openings which lead directly into infundibular enlargements, from which fine canals pass at right angles to the primary axis. They do not appear to be ciliated. From the primary axis branches are given off in all directions and traverse the parenchyma. The relation of these to the formation of the longitudinal musculature is very remarkable; the canal leads into an enlargement in which are inclosed longitudinal muscles; these appear to be comparable to the water-vascular system of Planarians. They are quite primitive in structure, and cannot be regarded as an independent system, but as a body-cavity which communicates with the outer world by a pair (or possibly more) of orifices. The musculature is closely connected with the layer which forms the surface of the body; of this there is, first, a well defined body-epithelium, which consists of cylindrical cells; dorsally there are large gland-cells, the contents of which are clear and transparent. At the base of the epithelium there are a large number of interstitial cells, and there is a basal membrane, which appears to be quite homogeneous and elastic, and has no indications of any cellular elements; this membrane varies in thickness in different parts of the body.

The muscles belong either to the dermal system, in which we find all the superficial layers, to that of the dorso-ventral fibres, or to the special supply of the ctenophoral plates and tentacles. Among them we find a special system of longitudinal fibres which cannot be homologized with any found either in Ctenophores or Planarians; it is that which supplies the stellate dorsal structure. Each longitudinal muscle represents a single bundle, the middle is occupied by strong fibres, and at the periphery there are thin corresponding cell-nuclei, which surround the bundle on all sides.

The author regrets that he was unable to make a complete study of the nervous system; with regard to the otolith-vesicle, he tells us that the pit is bounded by a ridge-like thickening; the base is somewhat complicated in structure; exactly at its centre there is a clear spongy mass formed of connective tissue, and containing but few nuclei. On either side there is a group of special gland-cells, the nuclei of which are all collected at the base. More peripherally there are two aggregations of elongated, almost filamentar elements, which are so arranged as to have a conical form. Still more peripherally there is a structure which is formed of rows of cells. These carry stiff hairs which form a support for the vesicle. At the edges of the

vesicle, just beneath these cells, there is an aggregation of cells from which fibres (possibly nerve-fibres) are given off in various directions. These fibres are best developed at the base of the otolith-sac, and give off on either side a branch which traverses the parenchyma of the body, and some fine branches which supply the sensory tentacles.

In their movements *Ctenoplanæ* present some resemblances to the Polyclads. In the form of their body they differ from the Ctenophora and approach the Planarians; as in Polyclads the body is flattened from above, and there is a similar investment of cilia. In the ribs or ctenophores they resemble the Ctenophora. Their gastro-vascular system is like that of *Cœloplana*, while the arrangement of the canals recalls rather the Polyclads than the Ctenophora. The musculature appears to be special and peculiar. On the whole, we must conclude that *Ctenoplana*, like *Cœloplana*, is an intermediate form between the Ctenophora and the Planaria; *Ctenoplana* is more like the former, *Cœloplana* the latter, and yet the two genera are very closely allied.

Bipalium kewense.*—Prof. F. Jeffrey Bell particularly directs attention to the fact that, during life, the form of this species of *Bipalium* varies so much that the "hammer-headed-shark" like form of the head must not be depended on as a generic character. The worm varies much in form and size. This species appears to have now become acclimatized in this country, but its original home is still unknown; Mr. O. Salvin † thinks that it must be from some temperate region.

Floscularia ornata.‡—Mr. W. N. Hastings writes that he found *Floscularia ornata* abundant in small ponds (peat-holes) early in the spring, while the ice was thawing. Their occurrence under these conditions he has observed for several seasons, but has not seen the fact recorded.

Revivification of Rotatoria and Tardigrada.§—That even science does not escape a certain taint of traditionalism has been frequently illustrated. Thus Trembley's often-cited statement that a *Hydra* turned inside out, still survived and may be modified into the original form, has been shown by recent experiment to be without foundation. In the same way, it seems certain that another fragment of received doctrine—which asserts the resurrection or revivification of desiccated Rotifers and Tardigrades—must give way before a less mysterious interpretation of the facts. The original observations of Spallanzani and Dugès, though corroborated in such an excellent monograph as that of Eckstein, have been not a little discredited by the results of Plate and Pouchet, while Prof. O. Zacharias has been led most conclusively to the same result, viz. that the desiccated forms always die, while their encysted and protected *eggs* frequently survive.

Near Prof. Zacharias's residence is a large granite block which has lain there for 200 years, and having a cavity holding 2–3 litres,

* Proc. Zool. Soc. Lond., 1886, pp. 166–8 (1 pl.).
† Tom. cit., p. 205.
‡ Amer. Mon. Micr. Journ., vii. (1886) p. 118.
§ Biol. Centralbl., vi. (1886) pp. 230–5.

which evaporates in from 2–6 days, according to the weather. In the collected rain-water a characteristic fauna was found to exist, notwithstanding the periodical desiccation. A peculiar variety of *Philodina roseola* seemed to have grown up in that habitat, as well as a Tardigrade, an *Amœba*, Flagellates, a *Stylonychia*, Volvocineæ, *Hæmatococcus pluvialis*, &c. Observations made nearly fifty years ago indicate the presence at that date of a similar fauna, and there is every reason to believe that at least for a century similar forms have tenanted the cavity. Thus the fauna has persisted, in spite of complete desiccation—thousands of times repeated. The problem is, how?

As the result of experiments, Prof. Zacharias found that specimens of *Philodina* and Tardigrada, when allowed to dry, *invariably died*, but that the ova were by encystation preserved from death by desiccation. To the eggs, therefore, which develope with returning rain, the "revivification" is wholly due.

What has thus been shown in regard to the Rotatoria and Tardigrada has been demonstrated by Hallez as to small Nematodes (*Rhabditis aceti*), which were also credited with revivification. The zygospore stage of *Stephanosphæra* and the resting stage of *Hæmatococcus* explain the persistence of these algoid forms in the pool; while the *Amœbæ* and Flagellata doubtless adopt similar protective measures. There is therefore probably no such thing as a real fauna and flora rediviva.

Prof. Zacharias further notes how the selective process has resulted in the development of a special variety of *Philodina* (*P. cinnabarina*) of large size, bright colour, and bolder habit, resulting from the absence of enemies.

Development of Balanoglossus.*—Mr. W. Bateson continues his account of the development of *Balanoglossus Kowalevskii*, and has some notes on *B. salmoneus* and *B. robinii* from Brittany. The skin is ciliated, and the long cells of which it is composed regularly anastomose with one another, so that the surface of the skin is made up of a sort of honeycomb of tissue, each of whose nodes is the outer end of an ectoderm cell. Inferiorly each cell is continued into a long and very fine filament, which may be followed into the layer of nerve-fibre, which is always more or less developed at the base of the ectoderm-cells over the whole body. Teased preparations always reveal the presence of large spindle-shaped cells, which appear to be broken off from the ends of the long ectoderm cells, and not to be the elements of a second layer. The resemblance between the skin of Nemertines and that of *Balanoglossus* is very close. Nerve-fibres of ectodermic origin are present in abundance, and appear to be motor nerves; the concentration of the nerve-fibres is most marked in the region of the collar. The skin covering the liver-saccules is very thin, and in *B. salmoneus* is often fused with the hypoblast, forming openings which place the cavities of the hepatic diverticula in actual connection with the exterior.

The radial muscular fibres are much more common in *B. salmoneus*

* Quart. Journ. Micr. Sci., xxvi. (1886) pp. 511–31 (6 pls.).

and *B. robinii* than in *B. Kowalevskii*; their peripheral ends are very long and fine, and occasionally branch, while their central ends taper suddenly; the former are probably inserted into the skin, and the latter into the meshes of connective tissue which permeate the body-cavity.

Passing from the outside to the centre of the proboscis, the parts are found to be thus arranged:—

1. Ectoderm.—Ciliated tailed cells.
   Glandular cells.
   Nerve-fibres as a layer.
   Basement membrane.
2. Narrow tissue space crossed by fibres from the ectoderm, by supporting fibres going in all directions, and a very few circular fibres.
3. Tract densely filled with radial and longitudinal muscles and connective tissue.
4. The tissue space into which the central organs project.
5. The central organs:—
   (*a*) Proboscis gland, with its sac.
   (*b*) Heart.
   (*c*) Notochord.

In *B. Kowalevskii* and *B. salmoneus* the dorsal mesentery persists throughout life; in other species it disappears in the region of the collar; the ventral mesentery persists in the trunk, but is always obliterated in the collar.

The proboscis gland first appears as a space in the proliferation of mesoblast lying dorsally to the anterior end of the notochord, at about the age of two gill-slits; it soon becomes inclosed in a membrane, and its cavity communicates with the body-cavity by means of the intestines between the cells bounding its anterior end. The heart arises at the age of three gill-slits, as a horizontal split in the tissue between the notochord and the sac of the proboscis gland; its walls are very thin, and soon become slightly muscular.

There is evidence in support of the view that the ovaries are of epiblastic origin, and they are at any rate from almost their earliest appearance connected with the skin in the dorso-lateral regions; they at first consist of a mass of loose round cells. The testes occupy the same position as the ovaries, and form lobed masses; the outer zone is made up of spherical cells which contain several dots; the cells are young spermatoblasts, and the dots the heads of spermatozoa.

Echinodermata.

Circulatory System of Echinoids.*—M. R. Koehler has come to the conclusion that M. Prouho is right in asserting the existence of five pharyngeal vessels in *Dorocidaris*, and he has been able to extend this observation to other genera of Echinoids. He does not, however, agree with that naturalist in his view of the homology of the sand-canal of *Spatangus* with the Polian or peri-œsophageal rings of the Cidaridæ; he thinks that the latter are rather homologous

* Comptes Rendus, ciii. (1886) pp. 86-8.

with the buccal rings of the Spatangidæ. He is of opinion that the circulatory system of both regular and irregular Echinoids is fundamentally similar; that there are not two systems absolutely distinct from one another, since in the regular forms the two peri-œsophageal rings are either connected by anastomoses, or by the branches which each of them sends into the Polian vesicles, and since in the irregular there is a disappearance of part of the sand-canal. The sand-canal and the glandular canal of *Echinus* is represented in *Spatangus* by the structure for which he retains the name of sand-canal, although he recognizes that it is formed of two vessels.

Hamann's Researches on the Echinoidea.*—Prof. P. Martin Duncan has satisfied himself that the "globifera" of Hamann are glandular organs and distinct from the pedicellariæ globiferæ of *Sphærechinus*. He points out that the glandular globes are more united at their common base than Hamann's diagram would indicate; that their function is partly the same as that of the similarly named pedicellariæ, and he suggests that they are modified pedicellariæ.

Vascular System of Dorocidaris papillata.†—M. H. Prouho states that in *Dorocidaris papillata* the sand-canal opens directly into the madreporic plate, together with another duct, and into a single orifice towards which all the aquiferous pores converge. The so-called blood-vascular system has its ring communicating with the intestinal absorbent vessels by the œsophageal branch of the internal marginal vessel. The ring also gives rise to a vascular plexus which is distributed over the ovoid gland, and is continued into the mesenteric layer, which unites the five central glands. The ring also gives rise to five pharyngeal vessels, the existence of which has been denied by preceding French authors. The blood- and water-vascular systems are intimately connected by means of their respective rings. The author does not agree with Prof. Perrier in thinking that Echinoids have only one vascular system; nor can he agree with those who think that the two systems are entirely distinct. The cavity of the ovoid gland is continuous with that of the duct which opens beside the sand-canal. This duct has nothing to do with the blood-vascular system, and the gland itself appears to be the seat of production of the flagellate cells which are so abundant in the perivisceral cavity.

Functions of Ovoid Gland, Tiedemann's Bodies, and Polian Vesicles of Asterida.‡—M. Cuénot finds that the ovoid gland, the bodies of Tiedemann, and the Polian vesicles have one and the same function. They form the pigmented corpuscles which float in the liquid of the vessels and of the general cavity. Their histological constitution is the same, being made up as it is of connective fibres supporting pigmented cells. The ovoid gland is closed, while the bodies of Tiedemann and the Polian vesicles open into the oral ambulacral ring. The author states that at certain times the gland allows its desquamated cells to escape into the body-cavity. If a specimen is

* Ann. and Mag. Nat. Hist., xviii. (1886) pp. 66–9.
† Comptes Rendus, cii. (1886) pp. 1403–6.
‡ Ibid., pp. 1568–9.

opened at such a time the conversion of the glandular cells into a blood-corpuscle may be seen to be effected very rapidly. In *Asterina gibbosa* the gland is divided into three lobes.

Regeneration of Visceral Mass in Antedon rosaceus.*—Mr. A. Dendy carries further the observations commenced by Prof. Milnes Marshall on the regeneration of the visceral mass in the common Rosy Feather-star. There are differences in the resistance which the mass offers to evisceration, and it was observed that the mass was more firmly attached to the calyx in those specimens in which the pinnules were found to be much distended with genital products. It is possible that these facts are to be correlated, the energies of the animal not allowing of reproduction simultaneously with the reparation of such an amount of tissue as is represented by the visceral mass.

Regeneration appears to commence by a series of outgrowths from the thin layer of connective tissue which forms the floor of the visceral basin, and by an ingrowth of connective tissue and epidermis from the edges of the injured area. The latter forms a roof to the visceral basin. It is not certain how the alimentary canal is formed, but the author thinks it probable that it is effected by invagination. The ambulacral grooves appear to be areas in which the regenerating tissue is less thick than elsewhere. Thickening seems to take place centripetally.

Mr. Dendy suggests that evisceration is a normal occurrence in *Antedon*, and is due to the fact that if any irritating particles or dangerous parasite be taken in as food the only way in which the obnoxious matter could be got rid of would be by the casting out of the alimentary canal. Owing to the structure and relations of this part the process is best effected by rejecting the entire visceral mass.

Variations in the form of Cirri in Comatulæ.†—Dr. P. H. Carpenter describes the cirri of *Antedon phalangium* as being of four different types, which he groups as long-jointed, intermediate, square-jointed, and short-jointed. This variation is the more remarkable since in most Crinoids the cirri are very constant in their characters.

Comatulæ of the Willem Barents Expedition.‡—Dr. P. H. Carpenter gives an account of the four *Antedons* collected by this expedition. Of them *A. barentsi* is a new species, most remarkable for the extensive development of the anambulacral plates in the perisome of the genital pinnules, wherein it resembles the Comatulæ of the Caribbean Sea and Oceania.

Cœlenterata.

New Form of Fresh-water Cœlenterate.§—In 1871 Owsjannikow‖ described a peculiar parasite in the ova of *Acipenser*, and his report

* Studies from the Biological Laboratories of the Owens College, i. (1886) pp. 299–312.

† Trans. Linn. Soc. Lond.—Zool., ii. (1886) pp. 475–80 (1 pl.).

‡ Bijdragen tot de Dierkunde, xiii. (1886) pp. 1–12 (1 pl.).

§ Morphol. Jahrb., xii. (1886) pp. 137–53 (2 pls.).

‖ Arbeit. dritten Russ. Naturf. Kiew. Reported in Zeitschr. f. Wiss. Zool., xxii. p. 292.

was corroborated two years later by O. Grimm.* The form described has turned out to be a stage in the development of a free-living hydroid organism. For the last two years this indubitably Cœlenterate form has been the subject of Dr. M. Ussow's researches, of which only a preliminary notice has as yet been published. Related as this form undoubtedly is to the Hydromedusæ, the peculiarities which it exhibits seem to warrant the invention of a special title—*Polypodium hydriforme*. The life-history of *Polypodium* is divisible into three stages,—first, as a parasite in the eggs of *Acipenser ruthenus* in the form of a cylindrical, spirally twisted tube with numerous lateral buds; second, as a free-living form, equipped with 24, 12, or 6 tentacles, and dividing itself very frequently; and third, presumably as a sexual animal.

After noting the extent, diagnosis, results, &c., of the parasitism, Dr. Ussow describes the parasite itself. The youngest specimen observed had the form of a cylindrical, hollow tube, 15–17 mm. in length, 1½–2 mm. in thickness, and superficially beset with primary buds. The walls consist of single layers of ectoderm and endoderm and of spindle-shaped (mesoderm) cells between. As this muscular-layer developes, the body becomes spirally coiled in the longitudinal axis of the sturgeon's egg. The primitive buds become pear-shaped, and the axial cavity of the organism is continued into each bud.

Each of the primitive buds soon exhibits a gradually deepening furrow, dividing it into two pear-shaped bodies—the secondary buds. These are afterwards developed into free-living forms. The secondary buds come, in consequence of spiral twisting, to lie on one side of the whole organism ("stolon"), on that turned towards the chorion of the egg. The ectoderm cells next the central yolk are filled with yolk-granules, which they have directly ingested. The yolk-substance thus acquired penetrates through the endoderm into the cavity of the buds and accumulates as reserve material.

The upper portion of the secondary bud exhibits a shallow furrow, and represents the lower aboral end of the future free-living form; and the furrow extending parallel to the long axis indicates the direction of a division which results in the halving of the free generation (or "mothers").

Tentacles are developed, as invaginate tubes, and exhibit all the three layers. Of the 24 tentacles, eight are specially differentiated, as short, strong, terminally swollen "Senktaster." They exhibit numerous stinging cells developed in special cnidoblasts. The other 16 are symmetrically arranged in pairs on both sides of the bud; they are thinner and much longer than the other eight. The tentacles are gradually and irregularly evaginated, the stolon begins to move, and eventually effects its liberation during spawning.

After being in water for 24 hours or so, the whole stolon falls into 32 pieces, representing the 32 buds; and this disruption occurs in a perfectly definite fashion. The buds have changed their form considerably since their first formation, and after liberation the old

* Arbeit. Naturf. Gesell. Petersburg, 1873, Taf. ii.

stalk and an adjacent portion of the stolon form a movable proboscis, at the end of which a mouth-opening eventually appears. After the disruption of the stolon the individualized buds seem to be nourished at the expense of the yolk stored up in their cavities. These cavities, which extend even to the end of the tentacles, may be justly termed gastral cavities.

The liberated mother bud (B) with 24 tentacles, divided into two daughter-forms (B^1) with 12 each. These divide and give rise to two different forms, B^2 and B^2b. The successive multiplication of the different generations is fully discussed and tabulated, and the three forms are described.

In regard to the *histology*, only a few notes are as yet communicated.

1. The ectoderm is somewhat folded laterally, and still more, inferiorly. Between the elements long drawn out cells were observed, which bore a transparent hair projecting above the level of the ectoderm. These may be reasonably regarded as sensory cells. On both sides of the mouth, where the proboscis passes into the main stem, two round masses of cells are seen. They consist of elements larger than the ordinary ectoderm cells, and may be regarded as ganglia. The presence of nerves was not demonstrated. After two or three days' free life the *Polypodium* acquires a light green colour, due to the presence of pigment-granules, suspended in the protoplasm of the ectoderm cells.

2. The endoderm exhibits a swelling at the aboral end of the body. In the region of the proboscis, also, a small annular fold projects freely into the inner space, representing perhaps a primitive funnel-shaped œsophagus. At the oral opening the endoderm passes directly into continuity with the ectoderm. The cells exhibit contractile root-processes. The ectoderm cells occasionally unite, obliterating the lumen in the tentacles and also in the large internal spaces in the generations B and B^1.

3. The mesoderm is represented by the slight muscular sheath of spindle-shaped cells, and is best developed in the proboscis and at the origin of the tentacles. At the transverse aboral furrow, on the other hand, it is rudimentary. This corresponds with the creature's habit of sitting and moving on its tentacles.

In a postscript, Dr. Ussow describes a younger larval form which had not yet reached the stolon stage. He regards *Polypodium* as a hydroid organism, with a motile "trophosome" (B) passing through various asexual generations before attaining the sexual (possibly medusoid!) form. The planula of the latter migrates into the ovum of *Acipenser*, and gradually developes into the stolon with primary and secondary buds.

Relation between the Skeleton and the Tissues in Madrepores.*—Herr G. v. Koch has, by clear definitions and diagrams, done much to facilitate the understanding and discussion of Madrepore structure. In the skeleton the following main portions are to be distinguished.

* Morphol. Jahrb., xii. (1886) pp. 154–60 (1 pl.).

I. *The basal plate.*—This is excreted between the aboral terminal surface of the body, and the substratum to which the skeleton is attached.

II. *The external plate* or epitheca.—This is a continuation of the basal plate, and yet more or less distinctly separable from it. It incloses the lateral body-wall, but does not, otherwise, come into contact with the substratum.

III. *The internal plate* or theca.—This rises from the basal plate in the form of a circular ridge, usually parallel to the external plate, and generally ensheathed in an intruding fold of the body-wall. There may be more than one internal plate.

IV. *The radial plates* or septa.—These are represented by numerous radial ridges, which ascend at right angles to the basal plate, and lie in radial folds of the body-wall, which alternate with the parietes (mesenteries).

These definitions are further explained, and it is also noted—

(*a*) That the body-wall always lies between the external and internal plates ;

(*b*) That the parietes always lie between two radial plates, and that the latter are, for some distance upwards, always separated by the internal plate into a peripheral and central portion ;

(*c*) That the external plate is only clothed with tissue on its inner surface, but the internal plate on both surfaces ;

(*d*) That where the radial plates come into secondary contact with the external plate, they penetrate the body-wall.

From the above definitions, taken along with the fact that the skeleton is excreted by the ectoderm, a number of important conclusions may be deduced as to the origin, growth, and structure of the skeleton.

1. All parts of the skeleton are laid down as plates, and their growth is effected by the apposition of new particles on those already formed.

2. As to superficial increase, all parts of the skeleton are alike, but they vary in the mode of their increase in thickness. The thickening of the basal and external plates is only effected from one side, while that of the internal and radial plates may take place from both.

3. In the basal and external plates the oldest portions are thus obviously on the outer side, and the newer portions are inwards.

4. In the internal plate the oldest portions are on either side covered by successive strata, but the growth on either side may be disproportionate.

5. In the radial plates the oldest portion is in the middle, and the subsequent depositions are symmetrically laid down on either side.

These definitions and conclusions, which are stated with the greatest conciseness and clearness, are accompanied with several very lucid figures, and are applied to a score or so of instances, in the examination of which the author was able to avail himself of numerous living forms.

Porifera.

Metamorphoses of Oscarella lobularis.*—Dr. K. Heider has investigated the development of *Oscarella lobularis* O. Schm. with valuable results. His descriptive memoir is accompanied by suggestive theoretical observations.

After giving an historical summary, Dr. Heider describes (I.) *the blastosphere stage.* The appearance of the free-swimming larvæ, their movements, their occasional attachment, &c., are described, while their histological characters are very fully discussed. The blastosphere exhibits a single layer of long, prismatic, ciliated cells round a central cavity which contains non-cellular, granular, albuminous substance. The variations in the ciliated cells in different regions are noted. Each consists of an inner larger portion—the granular endoplasm, with a store of food-material, and an outer portion—the clear exoplasm with a more definite outer fringe, forming a collar. All the prismatic ciliated cells exhibit a distinctly developed collar. Dr. Heider notes very carefully the intracellular prolongation of the cilium, which is continued within the cell to the neighbourhood of the nucleus. He compares this result with similar observations by numerous investigators. In some cases the root of the flagellum bears on its course, near the base of the collar, a roundish clear body, forming a sort of joint. Besides the flagellate cells, thicker and shorter pear-shaped forms here and there occur. The narrow neck bears a well-developed collar, but no flagellum. It is possible that they may be in some sense secretory.

II. *The Gastrula.* (*a*) *Free-swimming.*—The blastulæ become less active, and either come to rest or exhibit only a gentle rotation. They increase in breadth, and invagination occurs generally towards evening. The lower posterior cells seem to be invaginated into the anterior, but the reverse seemed an occasional occurrence. The cells retain their characteristics, the primitive body-cavity is still traceable between the two layers after invagination, and the blastopore is seen as a wide circular aperture.

(*b*) *Attached.*—The gastrula fixes itself by the cells round about the blastopore, and pseudopodia are associated with the process. The whole larva becomes much broader, more transparent, and more uniformly coloured. The endoderm cells are not essentially modified, but those of the ectoderm are entirely changed. The collar disappears, and in some cases probably the flagellum also; the long prismatic form becomes short, and finally cubical; the difference between exoplasm and endoplasm is no longer demonstrable; and the nucleus is drawn to the base of the cell.

(*c*) *Narrowing of blastopore.*—The next striking change is the narrowing of the blastopore by an all-round uniform contraction of the margin. A floor is thus made to the gastral cavity. Apart from various changes in external contour, &c., the endoderm exhibits an active progressive growth, and becomes somewhat folded.

* Arbeit. Zool. Inst. Univ. Wien (Claus), vi. (1886) pp. 175-236 (3 pls.).

(*d*) *Morphological differentiation of the endoderm.*—Dr. Heider gives a most interesting account, accompanied with lucid diagrams, of the formation of ciliated chambers from foldings of the endoderm. We have first to note the formation of flat diverticula, mostly towards the upper or aboral surface. It is as if the endoderm forms over the entire periphery of the aboral surface a prominent pad, which is very variously interrupted in its course. The sacs which interrupt the continuity of this pad are quite irregular in their distribution. Soon, however, radial folds appear, pushing the peripheral pad inwards, producing a zigzag pattern. The pad is further divided into separate segments by cross folds, and these segments are again divided into outer and inner portions. Two circles of small diverticula thus result, and these are seen to be the rudiments of the ciliated chambers. Without the illustrative diagrams it is, however, difficult to summarize the differentiation of the folds.

(*e*) *Further processes till the closure of the blastopore.*—The long prismatic form of cell is wholly lost, and the yolk-like granules in the endoderm have disappeared. The cells round the rudimentary ciliated chambers are bottle- or pear-shaped; the collars are even more distinct; exo- and endoplasm are readily distinguishable. The other endoderm-cells round the large primitive gastral cavity are cubical and colourless, but still ciliated. Between the ectoderm and endoderm a middle layer of cells appears. This mesoderm seems probably derivable from cells which have migrated from the endoderm; at least, the facts that the first cells appear near the endoderm, that the youngest cells are histologically very like the endoderm cells, and that phenomena suggestive of migration were observed, have led Dr. Heider to support this theory of the origin of the mesoderm. The ectoderm cells are quite cubical, or sometimes even flatter. The development of the processes which serve, probably with the aid of some cementing secretion, to fix the larva, is described.

(*f*) *The definite formation of the ciliated chambers.*—The gastral cavity becomes distended with a watery fluid containing albuminous substances in solution; the flat larva increases in height and becomes hemispherical; the ectoderm becomes smoother, the smaller processes disappear, and the cells become less cubical and more flattened. More important changes, however, occur in the endoderm. The two rows of diverticula take up a more lateral and less superior position, the summit of the hemisphere is occupied by the flat, unchanged endoderm lamella within the two rows of diverticula. Through this the osculum will be formed. At the other end the basal endodermal lamella closes the mouth of the gastrula. The distribution of the diverticula and their definite modification into ciliated chambers are described. The afferent pores arise either by fusion of the two layers and consequent rupture, or more frequently the canal which feeds two chambers seems to arise as an ectodermic invagination. Small isolated chambers appear in the basal endodermal lamella. The mesoderm increases greatly.

(*g*) *The formation of the osculum.*—The ectoderm on the summit of the hemisphere is more and more raised from the endoderm. An

increasing quantity of gelatinous substance is formed between. Into this process a diverticulum of the oscular endodermal lamella penetrates, more and more completely filling it. At the end of the process, where ectoderm and endoderm meet and fuse, a small rupture occurs—the osculum. Except in the absence of efferent canals, the young sponge is now like the adult. Further stages were not observed.

III. *Theoretical.*—It is not possible, without too much historical matter, to review Dr. Heider's theoretical notes on sponge development and history. He discusses the metazoan character, the primitive form, the homology of the layers, the homophyly of the group, &c. Referring to promorphological (relation of axes), morphological (e. g. fixing by blastopore), histological and physiological differences, he advocates the complete separation of the Porifera from the Cœlenterata.

Relationship of Sponges.*—In a report on the embryology of *Spongilla fluviatilis*, Prof. A. Götte discusses the general relations of the group, and lays special emphasis on a developmental peculiarity which would prevent their being closely connected with the Cœlenterates.

In the development of *Spongilla*, a somewhat unequal total segmentation is succeeded by the formation of a "sterrogastrula" in which the original ectoderm has grown round the endoderm. At this stage the larva leaves the mother sponge. When it has fastened itself, however, to some foreign substance, a remarkable phenomenon is observed, the original ectoderm ruptures and disappears as the larva grows, and a new epidermis is furnished at the expense of the endoderm, which thus forms the whole sponge. He denies the division of the endoderm into special layers.

It has been noted, on the other hand, in relation to Götte's observation, that in some other animals, e. g. Nemerteans (*Lineus*), there is a similar loss of the original larval envelope, though it has not been demonstrated that the ectoderm disappears *in toto*.

Sponge-gemmules.†—M. A. Wierzejski has studied the nature of the gemmules in the fresh-water European sponges, and gives a fuller account of their histology and development than has yet been available. Apart from his description of their structure, and of the details of their development, his conclusions are as follows:—

The central kernel of the gemmules in all the sponges studied, is formed of a group of ordinary cells in the mother sponge. The elements forming the tegumentary coverings are analogous, and the mode of formation is in principle the same in all the species. The spicules and amphidiscs are formed outside the first envelope of the gemmule. The peculiar integument in *Trochospongilla erinaceus* Vejd. and in *Spongilla Lordii* Bow., are, in their origin, analogous to the slightly developed veil which is found between the amphidiscs in

* A. Götte, 'Abhd. z. Entwickelung d. Tiere. Heft III. Entwickelung d. Spongilla fluviatilis.' Hamburg and Leipzig, 1886. Cf. Naturforscher, xix. (1886) p. 290.

† Arch. Slav. de Biol., i. (1886) pp. 26–47 (1 pl.).

the species of the genus *Meyenia* (*Ephydatia*), and to the same veil as found between the spicules of *Spongilla*. This tissue, which consists of airy cells ("cellules aériennes"), acts as a hydrostatic apparatus, which has attained a special development in the two forms above-mentioned, *Trochosp. erinaceus* and *Sp. Lordii*.

The fresh-water European sponges may be grouped with reference to the structure and development of their gemmules:—

I. Forms which produce amphidiscs with toothed margins.

(*a*) Disposed in a single stratum on the chitinous envelope, as illustrated in a single species, *Sp. fluviatilis* (aut.), which M. Vejdowski would regard as a distinct genus, *Ephydatia*.

(*b*) Disposed in two strata, as illustrated in many forms with slight differences, which may all be referred to the genus *Meyenia*.

II. Forms which produce amphidiscs united by their margins, as represented in the single species *Trochosp. erinaceus* Vejd.

III. Forms which produce spinose needles homologous with the amphidiscs. These are represented by a whole series of flat ramified sponges of variable size and form, but referable to a single genus or even species of *Spongilla*, and by an unbranched form (*Sp. fragilis* Leid.), for which a new genus might be erected.

Vestibule of Dendrilla cavernosa.* — Under the heading of "Studies on Sponges" Dr. R. v. Lendenfeld groups this and the three following papers.

This is a new species, remarkable for its laxity of structure. The sponge is digitate; the skeletal fibres dark brown; oscula are never found at the *ends* of the digitate processes. The whole sponge appears hollow, the processes being cylindrical. This cavity or "pseudogaster" has its walls covered with inhalent pores; but no oscula are present. The pseudogaster is shut off from the water by the substance of the sponge; there being a delicate perforated membrane at the ends of the processes.

At the breeding season the "pseudogaster" is occupied by the embryos, which can escape and return through the pores in the membrane. These pores can be dilated and contracted, and thus the water current can be regulated. The author derives this closed vestibule from open ones by secondary folding, as is seen in *Halme*.

The histological structure of the "vestibule membrane" is described. Around each pore is a series of tangential muscle-cells, the pore being surrounded by flat epithelial cells; numerous peculiar unicellular glands, like those described by the author in Aplysillidæ, are found below the flat epithelium all over the membrane, forming an incomplete ring round each pore. Inside the muscle-cells are multipolar cells, which Dr. v. Lendenfeld regards as ganglia-cells, and the spindle-shaped cells, between these ganglia-cells and the edge of the pore, as nerve-cells.

Gigantic Sponge.†—Dr. v. Lendenfeld regards *Papillina* O. Schmidt and *Raphyrus* Bowerbank as distinct genera, and describes a

* Proc. Linn. Soc. N. S. Wales, x. (1886) pp. 557–62 (1 pl.).

† Ibid., pp. 562–8 (3 pls.).

new sponge from Port Jackson, *Raphyrus Hixonii*. The largest species is 300 mm. across, massive, rounded, with large "pseud-oscula" situated on rounded protuberances at the sides and upper parts. It is bright red in colour; spirits extract a deep orange-coloured pigment.

The canal system consists of a reticulate structure, as in *Halme*, formed of lamellous fibres. Most of the lacunæ belong to the inhalent system; the exhalent canals not forming extensive lacunæ. Several sorts of spicules are found. In the soft tissue certain granular wandering cells of various shapes are found, and the author assumes that they are connected with the digestive functions of the sponge. "They take up and absorb microscopic food-particles which may get into the lacunæ of the inhalent system, and there come in contact with the epithelium."

Sponge with remarkable colouring power.*—Dr. v. Lendenfeld describes *Halme tingens*, from which spirit extracts a yellowish pigment, and if paper or other substances be dipped into this solution they become dark violet; the colour, apparently, is precipitated from its solution in alcohol. The colour cannot be washed out by ether or water, nor by concentrated acid or strong alkalies, the former merely turning the blue to red. The chemical nature of the sponge is unknown. A very small piece of sponge is sufficient to colour an immense quantity of paper, &c. The author thinks some practical use may be made of this discovery.

Mimicry in Sponges.†—Dr. v. Lendenfeld describes four new sponges, of which *Chalinopsis imitans* imitates *Dactylochalina cylindrica* so closely, that he had placed them together as the same sponge till the Microscope showed him his error. *Chalinopsis dichotoma* in the same way imitates *Dactylochalina reticulata*. The genus *Chalinopsis* belongs to the family Spongidæ, whilst *Dactylochalina* belongs to the Monactinellæ. The reason of the likeness between many species of these two genera may be accounted for in different ways. The author adopts the view that the siliceous sponges are the ancestors of the horny ones. The Chalinopsinæ are related to the Chalinidæ. "It seems probable that the two above-named species of *Chalinopsis* are descendants of digitate Chalinidæ; they have lost the defensive spicules, of so great a value to *Dactolychalina*, but have retained the external appearance. It is probable that the species of *Dactylochalina* have undergone changes since then, and that these species of *Chalinopsis* have had to change their own shape accordingly, so as always to remain similar to a defensive sponge."

Alga forming a Pseudomorph of a Siliceous Sponge.‡—In examining several specimens of a new species of sponge, *Dactylochalina australis*, Dr. R. v. Lendenfeld found that three of them differed from the others in their greater rigidity, though resembling them in shape. The structure of the sponge is described, and also that of the three apparent variations, which the author finds to be algæ.

* Proc. Linn. Soc. N. S. Wales, x. (1886) pp. 568–9.
† Ibid., pp. 569–72 (4 figs.). ‡ Ibid., pp. 726–8 (1 fig.).

The stem and branches, which occasionally anastomose, and form a network, taking on the shape of the sponge in nearly every detail, are formed of ordinary vegetable cells, remarkable for their very thick walls. Spicules, like those of the sponge, were found on burning the alga; but no trace of the horny skeleton. The author regards this alga as one of the Florideæ: "The alga is a parasitic species growing in the sponge, extending throughout the whole body of it. The sponge is thereby resorbed by the alga, the soft parts and fibres disappear, whilst the siliceous spicules are left adhering to the outer side of the branches of the alga." This alga forms a true pseudomorph; and the author does not think it comparable to other more simple alga parasites in sponges.

Sponges from South Australia.*—Mr. H. J. Carter continues his description † of the sponges obtained from the neighbourhood of Port Philip Heads.

In this communication he prefaces his account of the calcareous sponges by a reference to Häckel's classification, and to Polejaeff's rearrangement of this system, and calls attention to the parts to be noted in a description of a sponge, e. g. general form, colour, and structure of the surface, and explains the terms which he uses in his description of the specimens. The author prefers "vent" for the aperture usually known as the "osculum"; the "cloaca" is the cavity into which this opens, and so on. The various terms used in describing acerate, tri-radiate, and quadriradiate spicules, such as "lanciform," "sagittal," "inarticulated," &c., are explained.

Clathrina cavata is a representative of a common British species, but differs from it in that the cylindrical prolongations on the surface communicate only with the dilated parts of the interspaces; in *C. laminoclathrata* the tabulated staple thread so common in the genus is replaced by a flat-soled staple; *C. primordialis* presents a still further approximation of the parenchymatous structure, which intervenes between the contorted tubulation, to the arrangement which obtains in the Leuconeæ and Teichonellidæ. The largest and most abundant species is *C. ventricosa;* it was found to be abundantly filled with large ova. In all eight new species of *Clathrina* are described.

In a subsequent paper ‡ he continues his account of the calcareous sponges, and describes 19 species; *Hypograntia* and *Heteropia* are new types; in the former there are large holes of intercommunication between the chambers, and in the latter the wall consists merely of sarcode supported on large sagittiform triradial spicules.

Protozoa.

Conjugation of Ciliated Infusoria.§—M. E. Maupas has studied completely the conjugation of *Colpodium colpoda*, *Paramecium aurelia*, and *Euplotes patella* var. *eurystomus*. He believes he is able to

* Ann. and Mag. Nat. Hist., xvii. (1886) pp. 431–41, 502–16.
† See this Journal, *ante*, p. 258.
‡ Ann. and Mag. Nat. Hist., xviii. (1886) pp. 34–55.
§ Comptes Rendus, cii. (1886) pp. 1569–72.

demonstrate the exchange of a nucleolar corpuscle between two conjugating forms, and the reconstitution, after separation, of a new nucleus and nucleolus from the products of this exchanged corpuscle. There are seven principal stages, and each of the first six corresponds to the duration of a division of the primitive nucleolus, or its products. The seventh, which is much longer than all the other six, corresponds to the period of the reconstitution of the nucleus and nucleolus, and terminates with their first fissiparous division. In *Euplotes patella* the exchange of the nucleolar corpuscle is effected by a special orifice which is provided with a vibratile apparatus.

The nucleolus and its products, during division, pass through a series of forms, of which five may be specially distinguished; each of these is characteristic of a stage in conjugation; the most important is that in which the nucleolus has a spherical form and is granular; the fundamental substance of the nucleolus is converted into a delicate filament, coiled on itself; it is in such a condition that the nucleoli are exchanged. It is not correct to say that the corpuscles are exchanged at the time when they are longitudinally striated. As soon as the exchange is effected, separation of the conjugating cells commences. The stage of nucleolar reconstitution commences thus; the nucleus and nucleolus are represented by two small corpuscles absolutely identical in size, form, and structure; that which is to form the nucleus grows rapidly, and soon becomes conspicuous. All this time the separated forms are without a mouth, take no food, and remain for the most part quite still. As the mouth begins to be reconstituted the nucleus takes on the form and position which is characteristic of the species; the cells take in food greedily, and after twenty-four to thirty hours of their new existence, during which they have grown to almost twice their size, they divide by fission. Sometimes the primitive nucleus breaks up and becomes absorbed, but in *Euplotes patella* a pigment sometimes forms with the new nucleus. In *Paramecium bursaria* it is completely retained, and fuses with the fresh nucleus.

Infusoria of the Gulf of Naples.*—Continuing the work of Prof. Entz, Dr. E. v. Daday has noted the occurrence and given diagnoses of some Infusorian forms hitherto unrecorded in the fauna of the Gulf of Naples or elsewhere. His list is as follows:—

Fam. Acineta Ehrbg. 1. A. levadiana Mereschk. 2. A. trinacria Gruber. 3. *A. neapolitana* n. sp. Fam. Enchelina St. 4. *Holophrya maxima* n. sp. 5. *Lagynus ocellatus* n. sp. Fam. Trachelina St. 6. Amphileptus gigas Clap. and Lachm. Fam. Colepina Ehrbg. 7. Coleps fusus Clap. and Lachm. Fam. Stentorina St. 8. Stentor auricula S. Kent. Fam. Tintinnodea Clap. and Lachm. 9. Codonella orthoceras Hæck. 10. *C. punctata* n. sp. 11. *C. annulata* n. sp. 12. *Dictyocysta ovalis* n. sp. 13. D. mitra Hæck.

Aerial Habits of Euglenæ.†—Dr. D. D. Cunningham states that at almost any season many of the tanks in and around Calcutta are

* MT. Zool. Stat. Neap., iii. (1886) pp. 481–98 (1 pl.).

† Sci.-Gossip, 1886, pp. 163–4. From "The Relation of Cholera to Schizomycete Organisms."

more or less covered by a scum of *Euglenæ*, which is of a bright brick-red colour in the morning, and of a vivid green in the evening, and which is much less conspicuous and defined during the day than it is from sunset to sunrise. These variations in its characters are dependent on recurrent periodic changes in the condition of the component *Euglenæ*. The definition, and specially the dry dusty aspect of the scum in the evening and early morning, are due to the fact that at these times the vast majority of the *Euglenæ* are aerial, and not aquatic, organisms, the cells containing the then encysted and passive protoplasts being raised in various degrees above the surface of the water, and in the majority of cases being entirely removed from contact with it, and projecting freely into the air. The relative inconspicuousness during the day is, on the other hand, due to the fact that they are then submerged, and swimming free in the water. The changes in colour are dependent on alterations in the relative amounts of red oily colouring matter, and especially in alterations in its distribution within the bodies of the protoplasts.

The scum is not, however, solely composed of *Euglenæ*, but, on the contrary, contains masses of the empty cysts and stems with dilated bases belonging to previous cycles of the encysted condition of the organisms. Bright dry weather tends to induce constantly increasing thickness in this scum, due to the fact that under such circumstances the normal cycle of developmental changes of form goes on recurring with unbroken regularity, and that accordingly, quite apart from coincident processes of multiplication connected with the encysted condition of the organisms, there is necessarily a constantly recurrent addition of increments of dead matter in the form of empty cysts and stems. Heavy downfalls of rain, on the other hand, tend to cause it to disappear, due to the fact that they both break up the sheets of empty cysts and stems, and by driving the *Euglenæ* down into the water tend to prevent their normal assumption of an aerial habit. So long, however, as conditions remain favourable to the regular periodic succession of the diurnal and nocturnal phases in the life-history of the *Euglenæ*, a steady increase in the scum goes on. Any scum of this nature, composed in considerable proportion of dead organic materials, affords a favourable site for the development of both saprophytic and parasitic organisms, and we accordingly find it crowded with infusorial, monadinic, and schizomycete forms. Among the latter curved forms are frequently and, under certain conditions, apparently normally present in very large numbers.

Dr. Cunningham goes on to show how "comma bacilli" can be obtained with certainty, and in large quantity, by taking a mass of this scum and introducing it into a glass of water. The *Euglenæ* die off, and a scum accumulates composed of their bodies, empty cysts and stems, sometimes to the depth of a quarter of an inch; curved schizomycetes, precisely resembling in their morphological characters those found in choleraic media, crowd the under surface of the scum. In two cases Dr. Cunningham succeeded in developing distinct commas in cultivations where the scum material was used with feebly alkaline agar-agar jelly.

Australian Fresh-water Rhizopoda.*—The following forms are described by Dr. R. v. Lendenfeld as occurring in the Botany Swamps; of these the first two are new species:—

Lieberkuenia australis n. sp. differs from *L. paludosa* in its more slender shape. The nucleus is spherical; pseudopodia straight and unbranched; shell, truncated cone.

Echinopyxis australis n. sp. resembles an *Arcella* with spines round the margin of the cell, which is without the hexagonal reticulations.

Amœba villosa Wallich is found creeping between the roots of *Sphagnum*. The nucleus is spherical and very large, and its structure can be well made out by osmic acid and acetic acid preparations.

Arcella vulgaris Ehr. *Lecquerensia spiralis* Lecq. *Difflugia pyriformis* Perty.

No peculiar form of Rhizopod has been found in the fresh waters of Australia. As the above, except the first two, resemble in every way known species, and it is impossible that they have travelled across the sea, it is probable that they are of great geological age. "The fact that no Rhizopods peculiar to Australia have been found, seems to indicate that no recent spontaneous generation has occurred."

Amphistegina of Porto Grande.†—M. de Folin has a note on this Rhizopod which was abundantly dredged by the 'Talisman' off Porto Grande, St. Vincent. He finds that, on the addition of nitric acid, each specimen may be seen to contain from 10 or 12, to 40 or 50, or even 150 diatoms. These organisms enter also into the composition of the tests of *Orbiculina*, &c.

Zopf's Monadina.‡—Of recent years the researches of Dr. W. Zopf, Cienkowski and others, have contributed greatly to our knowledge of those primitive Protists, some of which were long since described by Häckel under the title Monera. These interesting organisms have recently formed the subject of an important monograph by Dr. Zopf, in which it is seen that the simplicity of structure with which they were credited by Häckel has, with the aid of a more perfect technique, to a large extent disappeared.

I. *Vampyrella vorax* Cienk. In the living amœboid forms distinct nuclei were demonstrated. The granular protoplasm was seen to be disposed in reticulate strands, conditioned by the presence of numerous vacuoles. The meshes are not, however, empty spaces, but are occupied by firm bodies, 1–4 μ in diameter, and resembling starch-grains in their concentric lamination. The results of reactions seem to show that these bodies consist of paramylum. The division of the amœboid organism, to which Zopf gives the new generic title *Leptophrys*, was observed in all its phases. It seemed to be the expression not so much of physiological or morphological necessity, as of a forcible mechanical rupture. In one case the formation of a plasmo-

* Proc. Linn. Soc. N. S. Wales, x. (1886) pp. 723–5.

† Comptes Rendus, cii. (1886) pp. 1575–6.

‡ Zopf, W., 'Zur Morphologie u. Biologie d. niederen Pilzthiere (Monadinen), zugleich ein Beitrag zur Phytopathologie,' 45 pp. (5 pls.), Leipzig, 1885.

dium was observed, resulting in a multinucleated mass. At a certain stage the amœbæ form zoocysts, sometimes 250 μ in length, and 63 μ in thickness, enclosed in a smooth, colourless, cellulose-like membrane. A peripheral layer rich in paramylum granules, a more or less gigantic vacuole, containing undigested food, and numerous nuclei were readily distinguishable. The peripheral protoplasm eventually divides into two or more portions, forming young amœbæ, which escape through special holes in the wall of the cyst. The *Leptophrys* is undoubtedly able by its secretions to dissolve the carbohydrate and albuminous material of the algoid cells on which it is parasitic. The former results in paramylum; the latter nourishes protoplasm and nuclei.

II. *Vampyrella spirogyræ* Cienk. In this form, with its three phases—amœboid, zoocyst, and sporocyst, the protoplasm was seen to be differentiated only in the amœboid stage, but the structure was much obscured by the ingested food-material. An amœboid body (nucleus?) and contractile vacuoles were, however, demonstrable.

III. *Vampyrella variabilis* Klein. Amœboid corpuscles (nuclei?) and contractile vacuoles were demonstrated both in the amœboid and in the encysted phase of this parasite. Hæmatoxylin in alum solution was used for staining the living organism.

IV. *Vampyrella pendula* Cienk. Nuclei were observed not only in amœbæ and zoocysts, but also in young sporocysts. Besides these, one or more vacuoles occurred.

V. *Protomonas amyli* Cienk. The amœboid forms were put into a drop of distilled water, the margins of the cover-glass were smeared with "Provenceröl" to keep out the air, with the result that all the starch-grains were expelled. In the transparent amœbæ the nuclei were then demonstrable.

In the second part of his memoir Zopf describes a number of new Monadina.

1. *Diplophysalis stagnalis* Zopf. The cells of *Characeæ*, especially *Nitella*, were found in certain cases to contain numerous, spherical, ellipsoidal, or oval bodies, enclosed in a delicate membrane, and containing in their protoplasm orange or sepia-coloured particles, and also starch-granules. There are, on an average, about 30 zoocysts in a cell. Zoospores are soon formed which force their way out. These spores have a cilium at each pole, and measure about 8–12 μ. They exhibit a nucleus and a contractile vacuole. Division into two was frequently observed, though not hitherto in any of the zoospore-forming Monadina. They may leave their original cell-host and find another. Finally, the ciliated spores become amœboid forms. After copious nutrition and increase in size, they pass into the encysted phase (zoocysts). After a while individuals occur which form permanent spore-fructification (sporocysts). The amœboid form becomes quiescent and enclosed in a membrane. Within this the protoplasm separates itself from the food-remains, and forms a nucleated body within a thin skin. In this secondary star-shaped cyst, which becomes gradually yellowish brown, the protoplasm again shrinks up into one or two resting-spores.

2. *Diplophysalis Nitellarum* Cienk. This form, described by Cienkowski as *Pseudospora nit.*, differs from (1) mainly in the character of the sporocyst. The secondary cyst membrane is not stellate, but smooth or only slightly angular. In winter the contents are starchy; in summer they are yellow, or sepia-brown food-remains. The ripe resting-spore contains abundant reserve material which hides the nucleus. The resting-spore gives rise to zoospores, in the formation of which the nucleus is seen to break up into numerous, small, uniformly distributed spheres. The 20–40 spores work their way out independently.

3. *Pseudospora maligna* Zopf. This form was found in the protonema cells of various mosses. The zoocysts are spherical, and each exhibits an excentric vacuole enclosing brown food-particles. The finely granular protoplasm between vacuole and membrane breaks up into small portions which form the swarm-spores. These possess a single fine cilium, are extremely active, and leave the original cell for another. With increased nutrition, they become amœboid. By means of their pseudopodia, they lay hold of chlorophyll granules and utilize them. Finally, they pass into the encysted phase.

4. *Aphelidium deformans* Zopf. This form, closely allied to the above, was found in a *Coleochæte* associated with *Nitella*. Four stages may be distinguished—the parasitic spore, the amœba, the swarmspore-forming stage, and the resting-spore form. The young amœboid form grows till it fills the algoid cell as a homogeneous, finely granular mass, in which the reddish-brown chlorophyll remains are seen floating. No proper cyst is formed, but the protoplasm divides into numerous spores which find their way out. Resting-spores are similarly formed, sometimes on the same thallus.

5. *Gymnococcus Fockei.* In large Diatomaceæ (*Pinnularia*, *Stauroneis*, &c.) spherical forms occur, surrounded by abundant, brown endochrome remains. These are zoocysts, and the protoplasm divides into small amœboid spores, which are liberated and again find their way into similar cells. The endochrome material is digested. The resting-spore form was also observed, though not within a special cyst. When food is deficient, the developmental history is simplified. The swarm-spores become quiescent and form microcysts, which differ from the zoocysts in only forming one spore, and from the resting-spores, further, in the delicacy of their membrane and in the absence of reserve material.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

Structure of the Cell-wall.†—Prof. J. Wiesner records some very important observations on this subject.

The first deposition of cell-wall consists entirely of protoplasm, and as long as the cell-wall is growing it contains living protoplasm (dermatoplasm), but this is only visible to the Microscope when it occurs in broad tracts destitute of cellulose, and then penetrates the entire wall, as was first observed by Tangl.

The structure of the cell-wall is, not only at its first origin, but always, reticulate, corresponding to that of the protoplasm from which the cell-wall is always produced. The principal mass of a growing wall consists of small round organized structures, dermatosomes, formed from microsomes of the protoplasm or plasmatosomes, united by delicate strings of protoplasm as long as the cell-wall is growing. Out of these strings are formed new plasmatosomes and finally dermatosomes, and on this depends the growth of the wall, which is therefore essentially intercalary. The dermatosomes cannot, as a rule, be directly observed in the cell-wall, but become visible when the strings which connect them are absorbed or broken. This can be effected by various means, best by chlorine-water; also by treatment with a 1 per cent. solution of hydrochloric acid, with potash-ley, by drying at 50–60° C., or by pressure.

Mature dermatosomes are destitute of albumen, lifeless, but capable of swelling. The water is contained in the cell-walls in two forms: as "water of swelling" in the dermatosomes, and as capillary water of imbibition between them, and enveloping the strings. The union of the dermatosomes within a cell-wall is stronger than between those of two adjoining cells. A loose framework of fibrillæ comparatively easily soluble in reagents divides the so-called middle lamella into two pellicles, so that each cell has its own outer lamella. The cell-wall is properly neither fibrillar nor lamellar, but, according to the arrangement of the dermatosomes, is stratified in the direction of the threads, or fibrillar, or both, or apparently homogeneous. The optical differentiation of the layers or fibrillæ of the cell-wall is brought about by the regular alternation of dermatosomes and substance of the framework.

This occurrence of albuminous substances in the living cell-wall explains its chemical nature and metamorphoses better than the current theory, according to which cellulose is the first product in its

* This subdivision contains (1) Cell-structure and Protoplasm (including the Nucleus and Cell-division); (2) Other Cell-contents (including the Cell-sap and Chlorophyll); (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† SB. K. Akad. Wiss. Wien, Jan. 14, 1886. See Bot. Centralbl., xxv. (1886) p. 353.

formation, and the starting-point for the formation of other "products of transformation." The cell-wall represents, as long as it is growing, a living member of the cell. This is illustrated by the fact that there are cells in which the greater part of the protoplasm is still contained within the cell-wall, such as hyphæ of fungi with thick-walled growing ends.

Development of Starch in Plants germinating in the dark.*—M. E. Belzung gives the following as the general results of observations on this subject:—

Starch is always developed in the interior of leucites, and appears in them shortly after their differentiation in the protoplasm. The form of fully-developed leucites is nearly the same in all plants, viz. almost spherical. When once differentiated leucites do not divide; they rapidly acquire a limited size, which they do not exceed. The granules of starch which take possession of the leucites at the expense of their albuminoid substances always remain extremely small. When a plant developed in the dark is exposed to light, the green matter is first of all fixed in the leucites which contain starch. It is, therefore, formed from chloroleucites, which are, however, filled with starch before the appearance of the chlorophyll.

M. Belzung concludes that there are three kinds of starch, differing possibly in their physiological origin, viz.:—(1) Starch formed in colourless or green leucites, with resorption of the substance of the leucites, but without appreciable further growth (young plants, leaves); these starch-granules are always small. (2) Starch formed in colourless or green leucites, with complete resorption of the leucites, and with further growth (cotyledons of the bean, haricot). (3) Starch formed on the surface of leucites without apparent resorption of the leucites (*Phajus*). The last two kinds usually consist of grains of large size with differentiated concentric layers.

Soluble Starch.†—Dr. J. Dufour applies this term to a substance which he finds chiefly in the epidermal cells of the leaves of *Saponaria officinalis*, *Gypsophila perfoliata*, *Bryonia dioica*, *Ornithogalum umbellatum*, *Arum italicum*, species of *Hordeum*, and a few other plants belonging to widely scattered orders among both Monocotyledons and Dicotyledons. It is soluble in water and ordinary alcohol, much less so in absolute alcohol, and only with difficulty in ether, benzine, and chloroform; acids and alkalies extract it rapidly, but without any imbibition or swelling. Its most remarkable property is its power of combining with iodine to a substance crystallizing in beautiful blue needles, in addition to an amorphous condition. It crystallizes also itself in the form of yellowish spherocrystals, varying in diameter from 10 to 150 μ, which polarize strongly.

Dufour's "soluble starch" occurs not only in the epidermis of the leaves, but also in that of the stem and floral organs of *Saponaria* and *Gypsophila*, in the former genus abundantly in the epidermis of both

* Bull. Bot. Soc. France, xxxii. (1885) pp. 374–8.

† Arch. Sci. Phys. et Nat., xv. (1886) pp. 439–65. Bull. Soc. Vaud. Sci. Nat., xxi. (1886) pp. 227–60.

surfaces of the lamina of the petals, but not in the claw. The author believes it to differ altogether from ordinary starch in its physiological function in the life of the plant, being simply a secondary product of excretion. It is capable of being formed in darkness.

Occurrence of the Elements of Milk-sugar in Plants.*—M. A. Müntz identifies the substance contained in gum-arabic, hitherto known as arabinose, with galactose, agreeing with this substance in its specific power of rotation (+ 80°), its fusing-point (170° C.), and its property of yielding on oxidation a large quantity of mucic acid. The same was the case with all the gums examined which were obtained from fruits or the trunks of trees, or by extracting from various plants, or which are sold in commerce.

Reactions of three Red Vegetable Pigments.†—Herren T. F. Hanausek and R. Czermak describe the reactions of the pigments of the hollyhock, bilberry, and Chica. The pigments of the first-named two plants become light red in acids, green in alkalies, Indian-ink tint in borax, and are destroyed by calcium chloride and hydrogen. Chica-red is obtained by boiling the leaves of *Bignonia Chica* and *B. tinctoria*, appearing as a cinnabar-red deposit, when the bark of a tree called "aryana" is added to the water. Cotton is coloured a beautiful orange-red by this pigment. Acids change the red into oil- or wine-yellow, caustic potash or soda make the hyacinth-red alcoholic solution muddy; iron-sulphate and chloride turn it brown, hydrogen and calcium chloride remove the colour entirely, magnesium carbonate partially; sugar-of-lead turns it flesh-coloured. Treated with sulphurous acid, Chica-red becomes at first chrome-yellow, then somewhat turbid with development of sulphuretted hydrogen. If the solution is filtered, it fluoresces red-yellow, and deposits after a time a yellow sediment.

Exoderm.‡—M. P. Vuillemin proposes to define more accurately than hitherto the term exoderm, corresponding to the endoderm of Van Tieghem. Its definition must be anatomical and morphological rather than physiological. It is the outermost layer of the bark; and, like the endoderm, its functions may vary greatly under different circumstances, although it may also be the seat of special formations. It varies also in being more or less sharply differentiated from the subjacent layers.

Pericycle of Caryophyllaceæ.§—According to M. P. Vuillemin, the structure of the pericycle is very constant throughout the Caryophyllaceæ. It usually consists of two zones:—(1) An outer sclerenchymatous zone, the elements of which are sometimes fibres with scarcely any cavity, sometimes cells with thin but lignified walls; (2) an inner parenchymatous zone, the outermost layer of which

* Comptes Rendus, cii. (1886) pp. 624–7.

† Zeitschr. f. Landwirth. Gewerbe, 1885, pp. 131–3. See Bot. Centralbl., xxv. (1886) p. 254.

‡ Bull. Soc. Bot. France, xxxiii. (1886) pp. 80–4.

§ Ibid., xxxii. (1885) pp. 275–82.

gives birth to the bark, while the lower layers are more or less thickened in a collenchymatous manner. Its uniform function is to form a parenchymatous layer of sufficient thickness between the endoderm and the bundles. The lignification and formation of collenchyma in this layer are characters of no taxonomic value, since they depend on the action of external and internal media, and may vary even in different parts of the same stem.

Fibrovascular Bundles of Piperaceæ.*—M. F. Debray gives an exhaustive description of the anatomical structure and course of the fibrovascular bundles in the Piperaceæ, which he divides into three groups, viz. (1) Saurureæ, with 5 genera and 7 species; (2) Pipereæ, with 2 genera, *Chavica* with 5, and *Piper* (including *Artanthe*) with about 600 species, and (3) Peperomieæ, with 2 genera, *Peperomia* and *Verhuellia*, and about 400 species. The fibrovascular bundles in both stem and leaves of each division are treated of; also the axillary buds, the "apposifoliar" stipules, and the scape.

Fibrovascular Bundles and Secreting Apparatus of the Nymphæaceæ.†—From the point of view of the structure of the fibrovascular bundles, M. P. Van Tieghem distributes the genera of Nymphæaceæ into four groups, as follows, viz.:—1. *Cabombeæ*. Bundles of the stem and petiole all direct and coalescent in pairs by their xylem; those of the pedicel all direct and free (*Brasenia*, *Cabomba*). 2. *Nuphareæ*. Bundles of the stem, petiole, and pedicel all direct and free (*Nuphar*, *Barclaya*). 3. *Nymphæeæ*. Bundles of the stem all direct and free; those of the petiole and pedicel of two kinds; some direct and free, others double, formed of one direct and one inverse bundle united by their xylem (*Nymphæa*, *Euryale*, *Victoria*). 4. *Nelumbeæ*. Bundles of the stem, petiole and pedicel of two kinds, some direct, others inverse, all free (*Nelumbo*).

All the Nymphæaceæ are provided with laticiferous cells with thin and suberous membrane, and which are coloured by fuchsine. Their character varies as follows in the four groups:—1. *Cabombeæ*, of ordinary form, superposed in long threads; no oxaliferous cells. 2. *Nuphareæ*, of ordinary form, isolated; no oxaliferous cells. 3. *Nymphæeæ*. Fusiform and very long, isolated; no oxaliferous cells. 4. *Nelumbeæ*. Of ordinary form, isolated; oxaliferous cells in spheroidal groups.

The difference exhibited in these points by the Nelumbeæ, as contrasted with the other three tribes, is accompanied also by the presence of a sclerenchymatous sheath to the bundles, absent from the others, by the absence of both endosperm and perisperm, and the entire suppression of the radicle in germination. Contrary to the opinion of Bentham and Hooker, M. Van Tieghem considers that these differences represent a wide genetic separation of the Nelumbeæ from the typical Nymphæaceæ.

* Debray, F., 'Étude comparative des caractères anatomiques et du parcours des faisceaux fibro-vasculaires des Piperacées,' 107 pp. and 6 pls., Paris, 1886. See Bot. Centralbl., xxvi. (1886) p. 136.

† Bull. Soc. Bot. France, xxxiii. (1886) pp. 72–6. Cf. this Journal, iv. (1884) pp. 767, 770; v. (1885) p. 823.

Secreting System of Hydrocotyle.*—According to M. P. Vuillemin, the absence of oleiferous canals from the root, pericycle, and the cortical and medullary parenchyma of *Hydrocotyle vulgaris*, as contrasted with other members of the Umbelliferæ, is due to its small size and aquatic habit. In other species of the genus the suppression is not nearly so complete.

Laticiferous Vessels as Assimilating Organs.†—An examination by Sigg. R. Pirotta and F. Marcatili of the laticiferous system of a number of species of *Ficus*, leads them to the conclusion that these vessels are of no small importance in the direct conduction of the products of assimilation. In many species the latex-tubes which enter the lamina of the leaf from the petiole accompany the vascular bundles to their extremities, and often replace their conducting parenchyma; while in other cases these tubes are partially detached from the ends of the bundles, and run independently in the mesophyll as far as the pallisade-tissue.

Ducts in Chestnut-wood.‡—Mr. P. H. Dudley describes the structure and mode of formation of the ducts in the wood of the American chestnut (*Castanea vesca*). In this wood the large ducts in the inner portion of each annual ring are very conspicuous, attracting attention at once in the transverse and radial sections. They are formed in one, two, or three quite distinct concentric rows in the early spring growth of each annual ring.

Superficial Extent of the Underground Parts of Plants. §—M. A. Girard proposes a method of ascertaining the superficies of roots by placing them on a metal plate and throwing on them flowers of sulphur. They are then beaten until no more sulphur becomes detached. The portion still adhering forms a coating of a uniform thickness of about 0·1–0·2 mm.; this can be detached by a 10 per cent. solution of alcohol, and weighed.

Non-chlorophyllaceous Saprophytes. ‖—Herr F. Johow describes the chief points of morphological structure connected with the biology of several West Indian saprophytes destitute of chlorophyll, viz. *Burmannia* and *Apteria* belonging to Burmanniaceæ, *Wullschlægelia* to Orchideæ, and *Voyria* to Gentianaceæ.

All these genera have minute seeds with imperfectly developed embryo. In *Burmannia* the embryo lies at the apex of the endosperm, and consists of from three to six, or, in *B. capitata*, of ten cells. *Wullschlægelia* differs in no respect from other orchids. In *Voyria* the embryo-sac originates from the uppermost of the four daughter-cells of the mother-cell of the embryo-sac; the anatropous structure of the ovule being manifested at its very earliest period, and not developing later. The ovule is naked without any integument. The

* Bull. Soc. Bot. France, xxxii. (1885) Sess. Extraord., pp. ci.–civ.

† Ann. R. Ist. Bot. Roma, ii. (1885) pp. 48–9. See Bot. Centralbl., xxvi. (1886) p. 212.

‡ Bull. Torrey Bot. Club, xiii. (1886) pp. 91–2.

§ Comptes Rendus, xcii. (1886) pp. 1257–60.

‖ Pringsheim's Jahrb. f. Wiss. Bot., xv. (1885) pp. 415–49 (4 pls.).

embryo remains permanently exceedingly rudimentary, consisting, in perfectly ripe seeds, of at most four, sometimes of only two or three cells, and often of only one. The seeds will frequently attain their full size without developing any embryo-sac.

Fall of Branches of the White Poplar.*—When a large number of trees grow in close proximity, they in general lose their lower branches, the upper branches only growing and flourishing. M. Leclerc du Sablon has observed that, in the case of the white poplar, this loss of the lower branches is brought about by a process somewhat similar to that which causes the fall of leaves. A layer of tissue in close proximity to the trunk becomes strongly lignified. There is, however, no generating layer formed in the bark, as in the case of leaves; but simply lignification of the walls in the layers of cells above the corky layer.

First Vessels in the Leaves of Crucifers.†—M. A. Trécul describes the order of appearance of the vessels in the leaves of the cabbage and of some other crucifers, which is of the kind that he terms mixed, i. e. in basipetal succession in the lower, basifugal in the upper part of the leaf.

Structure of the Leaves of Water-lilies.‡—M. J. Costantin finds in *Nymphæa rubra* two kinds of leaves, one entirely submerged, which possess no stomata at all, the other floating, which have stomata on their upper surface only. The former kind are thin, transparent, arrow-shaped, and well adapted to be swayed by currents of water. In *Nuphar lutea* there are also two kinds of leaves, but they grow on different plants. When the yellow water-lily grows in very deep water, its leaves are all thin, transparent, with very flexible petioles, and entirely destitute of stomata. The difference between the two kinds of leaves is manifested very early, the stomata being developed on those which are destined ultimately to float, while they are still rolled up and entirely submerged.

Tendrils of Cucurbitaceæ.§—M. P. Duchartre points out that in the Cucurbitaceæ there are tendrils of two kinds as respects their development, viz. (1) tendrils which are coiled from the very earliest period of their formation, and which complete their coiling while still in the bud-condition; and (2) tendrils which are straight while in the bud-condition. This distinction does not correspond in any way to any natural system of classification of the members of the order into sub-orders or even into genera.

Glands of Bunias Erucago.‖—Sig. P. Pichi has examined the red spots on the stem of this plant, which he finds to be composed of glandular structures of the nature of emergences. They produce a colourless fluid with an acid reaction, but the author was unable to ascertain that they were visited by insects.

* Bull. Soc. Bot. France, xxxiii. (1886) pp. 25–7.
† Comptes Rendus, cii. (1886) pp. 575–81.
‡ Bull. Soc. Bot. France, xxxii. (1885) Sess. Extraord., pp. xv.–xix.
§ Ibid., xxxiii. (1886) pp. 10–19 (1 fig.).
‖ Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 5–9 (1 pl.).

Turgidity of the Pith and Leaf.*—Herr J. Böhm assigns reasons for believing that the turgidity of the pith is not the result of hydrostatic pressure in the cells, but of the swelling of the cell-walls, and especially of the longitudinal walls. The same is also true of leaves. Experiments were made chiefly on cylinders of the pith of the sunflower and tobacco. Cylinders of the latter, which, on drying, had lost 30–40 per cent. of their weight, usually became, when placed in a dilute solution of nitre or sugar, as stiff as icicles, although they often did not attain their original weight or length. If dried too quickly, they acquired much more than their original weight, even if placed in distilled water, without, however, becoming rigid; and this was always the case with perfectly white cylinders of the pith of the sunflower.

Influence of Light on the Structure of Leaves and number of Stomata.†—M. L. Dufour has determined, by experiments on a number of plants, that in strong direct sunlight the number of stomata on a unit of surface is larger, and the transpiration is more abundant, than in diffused light. He further states ‡ that leaves fully exposed to the sun have a larger surface than those growing in the shade, and that the same is true of the epidermal cells; that, in proportion as leaves develope, they acquire fresh stomata up to an advanced period in their evolution. It is the adult leaf last formed which has the largest surface, the most cells, and the largest number of stomata.

M. L. Mer § confirms these statements and regards the formation of stomata as due, in most cases, to a local multiplication of epidermal cells, followed by an arrest of development.

Influence of Water on the Number of Stomata.‖—M. J. Costantin has shown, by transplanting plants from one medium to another, that a direct influence is exerted on the number of stomata, those on leaves produced in the air greatly exceeding those on leaves produced in the water in the same plant. A rhizome of *Polygonum amphibium* was divided into two, and the two parts placed under precisely similar circumstances, except that one was grown in the water, the other in the air. The latter had a number of stomata on the lower surface of the leaves, the former none at all.

Biology of Unilateral Inflorescences.¶—Dr. J. Urban discusses the causes of the unilateral arrangement of the flowers in many inflorescences, which he arranges under the following heads, viz. Movements in the flower-stalks and in the axis of the inflorescence; Suppression of flowers on one side of the axis; Monochasy, either pure or resulting from the reduction of cymes.

* Bot. Ztg., xliv. (1886) pp. 257–62.
† Bull. Soc. Bot. France, xxxii. (1885) pp. 385–90.
‡ Ibid., xxxiii. (1886) pp. 92–5.
§ Ibid., pp. 122–6.
‖ Ibid., xxxii. (1886) pp. 259–64.
¶ Ber. Deutsch. Bot. Gesell., iii. (1886) pp. 406–32 (1 pl.).

β. Physiology. *

Cross-fertilization of Plants by Birds.†—Dr. Fritz Müller describes the structure of the flowers of an American shrub belonging to the genus *Feijoa* and order Myrtaceæ, adapting them to cross-fertilization by birds. When the flower is fully open, the petals roll up and become soft and very sweet, exposing only their outer surface, which is pure white; but no honey is developed which would be attractive to insects. The stamens are very numerous (50–60), dark blood-red, expanding above into a crown more than an inch in diameter, and with bright-yellow pollen. The blood-red stamens and pistil, yellow pollen, snow-white petals, and dark sepals, make the flowers, which are quite exposed, very conspicuous; and yet they appear to be seldom visited by insects. But the petals are devoured by birds belonging to the genus *Thamnophilus*, which, in so doing, necessarily carry the pollen from one flower to another, either the neck or head invariably coming into contact with the open anthers as they stoop down to bite the petals.

Evolution of Oxygen from Plants in the Microspectrum.‡—In pursuance of investigations already reported,§ Herr N. Pringsheim has carried on his researches on the portion of the solar spectrum which has the greatest effect in promoting decomposition of carbonic acid and consequent evolution of oxygen by plants. He uses for this purpose the bacterian method of Engelmann, but his results are not altogether in harmony with those of that observer.

Pringsheim finds that there is no constant coincidence of the maxima of absorption and of exhalation of oxygen either in the red or in the blue. Although the movement of bacteria in the red exhibits generally great energy, yet its maximum possibly never lies at the spot of maximum absorption B $\frac{1}{4}$ C, but generally behind C, usually nearly midway between C and D; and its position is subject to not inconsiderable variations even in different specimens of the same plant. In the whole of the blue-violet end of the spectrum the movement of bacteria is always extremely sluggish in comparison with the strong absorption in the chlorophyll which always takes place in this part.

All brown and red algæ have, in their absorption-spectrum, the dark absorption-band in the red corresponding to the chlorophyll-band I; but the maximum of evolution of oxygen is, in these plants, never in the red, but far in the yellow and green.

* This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

† Kosmos, i. (1886) pp. 93–8. See Science, vii. (1886) pp. 441–2 (3 figs.).

‡ Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 162–206 (2 pls.); and SB. K. Preuss. Akad. Wiss. Berlin, vii. (1886) pp. 137–76 (2 pls.).

§ See this Journal, ii. (1882) p. 220; *ante*, p. 105.

Causes of the Fall of the Leaf.*—Dr. H. Molisch gives the following as the more important results of observations on this head:—

If transpiration is suddenly stopped in branches which ordinarily transpire strongly, the leaves fall; while plants which thrive in a moist atmosphere often preserve their leaves for a long time in saturated air. A not too rapid but continuous diminution of the water in the soil tends to the formation of the separating layer, and in many cases to the fall of the leaf, which is then greatly favoured by the sudden saturation of the soil. The fall takes place indifferently whether the withering is caused by increased transpiration, by insufficient supply of water, or by both causes; but if the withering takes place too rapidly, the leaves dry up before the separating layer is formed. Cut branches which transpire slowly shed their leaves even when lying on the ground. An insufficient supply of water is also the cause of cut branches dipped in water losing their leaves earlier than when growing on the tree, and also of plants shedding their leaves when moved from the open soil into pots. Stagnant water in the soil injures the roots and causes plants partially or entirely to lose their leaves. The same result ensues from want of light. This is shown most by strongly transpiring plants with herbaceous leaves, such as *Coleus*, less by those with coriaceous strongly cuticularized leaves, such as *Azalea*, *Rhododendron*, and *Abies pectinata*, scarcely at all by evergreen conifers or by the box.

The influence of temperature on the fall of leaves is very complicated. It acts both directly, and indirectly by influencing the transpiration. Oxygen is an essential condition of the fall of the leaf; leaves immersed in water become detached much later than those growing in moist air.

The gum-ferment discovered by Wiesner † occurs in many plants in large quantities in the separating layer; this renders it probable that the absorption of the middle lamella, and the isolation of the cells, is completed by a cellulose-transforming ferment, assisted by organic acids.

Transpiration of Plants.‡—Sig. E. Pavani gives a full account of previous researches, as well as of fresh observations of his own, on the absorption of water by plants, especially trees, the amount of transpiration, and the influence on climate. This latter he considers to be greater than is generally supposed, and chiefly from the absorption of heat which must necessarily take place in the conversion of the water into vapour. Conifers, from the small amount of surface of their leaves, exercise much less influence, and are much more adapted to dry climates and an arid poor soil, than trees with larger leaves.

Causes of Torsion.§—Herr F. Kreuter details the reasons which have led him to the conclusion that the torsion of stems is due to the

* SB. K. Akad. Wiss. Wien, Feb. 11, 1886. See Bot. Centralbl., xxv. (1886) p. 393.

† See this Journal, *ante*, p. 106.

‡ Boll. Soc. Adriat. Sci. Nat. Trieste, ix. (1886) pp. 17–43.

§ Naturforscher, xix. (1886) pp. 211–2, 222–3, 231–2.

co-operation of a large number of small causes, but chiefly to unequal growth, caused by the attractive force exercised by the more refrangible rays of light on the chlorophyll-bodies, in consequence of which the cells on the side of the stem exposed to the sun are often larger than those on the shaded side. The same applies also to the twining of stems; and the author believes that this may afford an explanation of the apparently anomalous fact that light exercises a retarding influence on growth.

Causes of Twining.*—Dr. J. Wortmann sums up the facts known relating to the cause of the twining of stems, and concludes that it is due to a movement of growth only distinguishable from those of ordinary orthotropous stems which grow in a vertically ascending direction, in being caused, not only by negative geotropism, but also by rotating nutation which acts in a horizontal direction. The combination of these causes is sufficient to account not only for all true twining movements, but also for the torsions of the stem round its own axis, whether homodromous or antidromous, which result as secondary phenomena. A negatively geotropic shoot which is growing with sufficient rapidity may in this way acquire the faculty of coiling round a support. This view is supported by the observation of Noll,† which Wortmann confirms, that an etiolated seedling can, through the operation of circumnutation, coil like a true climbing plant.

Metastasis in the Crassulaceæ.‡—Dr. G. Kraus has made a detailed examination of the composition of the cell-sap in the succulent *Sedums*, *Sempervivums*, and other Crassulaceæ, and of the chemical changes which go on in it.

In addition to free malic acid he finds a very large amount of calcium malate; analysis of the leaf-rosettes of *Sempervivum* showed, in the dry weight, 3·2 per cent. free malic acid, 25·9 per cent. calcium malate, 4·5 per cent. sugar, 7·2 per cent. starch. The calcium malate acts the part of a reserve food-material, accumulating during the period of active growth for use when the flowers and fruits are being formed. For this purpose it is probably first decomposed into carbohydrates. The free malic acid is formed chiefly in the night, and is therefore not a direct product of assimilation, but is apparently the result of the activity of assimilation during the day. During the next day it again disappears entirely. A portion unites with lime to form calcium malate, which is stored up as a reserve-material. Another portion is re-transformed, by the action of light, into carbohydrates.

That the carbohydrates are really formed at the expense of the malic acid, is shown by the fact that the decrease in quantity of the latter is accompanied by a corresponding increase in the amount both of sugar and of starch, and that this is the case even in an atmosphere

* Bot. Ztg., xliv. (1886) pp. 273-83, 289-98, 305-6, 329-38, 345-55, 361-6 (3 figs.).

† See this Journal, *ante*, p. 283.

‡ Abhandl. Naturfgesell. Halle, xvi. (1886). See Naturforscher, xix. (1886) p. 177.

deprived of carbonic acid where no direct assimilation could take place. Malic acid contains a larger proportion of oxygen than the carbohydrates, and the transformation must therefore be accompanied by evolution of this gas.

B. CRYPTOGAMIA.

Underground Algæ and Fungi.*—Herr A. Schneider gives an account of the vegetable organisms found in coal-pits, salt-mines, and ore-mines in different parts of Germany. They comprise rhizomorphs, Mucorini, Pleosporeæ, diatoms, Oscillariaceæ, palmella-like colonies, micrococci, spirilla, &c.

Cryptogamia Vascularia.

Bursting of the Sporangium of Ferns.†—Herr J. Schrodt explains this phenomenon as follows:—The bursting of the sporangium, and the twisting of the free end of the annulus to the extent of 360°, are caused solely by the pressure of the atmosphere, which acts on the cells of the annulus through transpiration and evaporation. When this process is completed, the thin semi-cylindrical membrane of the sporangium very quickly attains the degree of dryness at which it becomes permeable to air under the pressure of one atmosphere. The air therefore enters the cells suddenly; and these in consequence assume nearly their original volume. But the air which enters in this way has not the tension of the atmosphere; since, in consequence of its entering the cell-cavity, the force of external pressure is so much diminished that it is no longer able to overcome the resistance of the air-dry membrane. The definite condition of the annulus results from the shortening of the thin membrane and the rarefaction of the air which is still present in the cells.

Fructification of Calamodendron.‡—M. B. Renault has carefully examined the structure of a large number of the spikes of *Calamodendron*, and has come to the conclusion, from the complicated structure of the sacs contained in them and that of the reproductive bodies which they inclose, that they must be regarded as pollen-sacs and pollen-grains, and that the *Calamodendra* are therefore shown to be flowering plants by the structure, not only of their roots and stems, but also of their fructification.

Development of Lycopodiaceæ.§—Dr. M. Treub has continued his researches on this subject, following up his previous observations with an examination of the development of *Lycopodium Phlegmaria*. The germination of the spores appears to be slow; but the oophore is capable of various modes of asexual multiplication; indeed it

* Programm der K. Realschule zu Berlin, 32 pp. (2 pls.), 1885. See Bot. Centralbl., xxvi. (1886) p. 33.

† Ber. Deutsch. Bot. Gesell., iii. (1886) pp. 396–405 (4 figs.). Cf. this Journal, *ante*, p. 479.

‡ Comptes Rendus, cii. (1886) pp. 634–7.

§ Ann. Jard. Bot. Buitenzorg, v. (1885) (20 pls.) See Prof. F. O. Bower in Nature, xxxiv. (1886) p. 145. Cf. this Journal, v. (1885) p. 277.

appears that the majority of the prothalli found owed their origin to this source, and not directly to the germination of spores, a similar phenomenon to that which occurs in the case of *Gymnogramme leptophylla*. The prothallus is as a rule devoid of chlorophyll, and consists of cylindrical branches covered with absorbing hairs. These cylindrical organs branch monopodially, the branches being usually formed in acropetal order; they have a terminal growth with two initial cells, each of which gives rise to half of the cylindrical organ. There is a great similarity between the structure of this apical meristem and that of the stem of the sporophore. In the fully differentiated parts of the prothallus a peripheral tissue one layer of cells in thickness may be distinguished; this gives rise to the rhizoids. The mass of tissue inclosed by this superficial layer, though it shows some slight varieties according to the mode of development of the branch, never attains any high state of differentiation.

The lateral branches, which are not very numerous, take their origin from the peripheral layer, several cells taking part in the formation of each. The growth of these branches may be long-continued, and it is not arrested on the formation of an embryo on another branch. By progressive rotting of the older parts, branches may be separated from one another, and this constitutes the simplest mode of increase in the number of individuals. But, besides this, two other modes of vegetative propagation are known—(*a*) by ordinary propagating organs: these are small ovoid multicellular bodies, which originate from single superficial cells, and are set free by rupture of their pedicels; (*b*) by thick-walled organs, smaller than the above, which only appear on weakly prothalli: these may undergo a period of rest. Dr. Treub compares these structures to the gemmæ of the Hepaticæ, and especially of *Blasia;* while in many of their general characters the prothalli of *L. Phlegmaria* show points in common with the oophore of certain of the Muscineæ.

The sexual organs of *L. Phlegmaria* are produced on the upper surface of the prothallus, and are always accompanied by paraphyses, structures which are absent from other Vascular Cryptogams. The position of the antheridia is variable; sometimes they are scattered singly on the vegetative branches, sometimes they are associated in groups, and are then often borne on the considerably thickened extremities of branches. Their development is similar to those of *L. cernuum*, while the antherozoids have two cilia, and resemble those of *Selaginella*. The archegonia have a more definite position, and they appear subsequently to the antheridia, on those thickened extremities of branches which have already borne antheridia: they project from the surface of the prothallus, and have three to five canal-cells. This is again a point in common with certain Muscineæ.

There is a considerable difference between the development of the embryo in *L. cernuum* and that of *L. Phlegmaria*, while in certain points the latter corresponds to *Selaginella Martensii*. Thus the ovum in *L. Phlegmaria* divides first by a wall perpendicular to the axis of the archegonium into two; of these, the cell next the neck

becomes the suspensor, the other is the mother cell of the embryo; the latter develops ultimately into a multicellular mass arranged in two tiers; the lower tier forms only the massive "foot," while from the upper (i. e. that further from the neck of the archegonium) are derived the stem and single cotyledon, and ultimately also the first root. The first root of *L. Phlegmaria* is at first covered by an envelope, a single layer of cells in thickness, which cannot rightly be regarded as the outermost layer of the root-cap; accordingly, we have the barest possible example of endogenous formation, only a step removed from the exogenous. As far as it is possible to judge at present, we find in the sexual generation of the Lycopods, more clearly than elsewhere, transitional terms between the great series of the Muscineæ and that of the Vascular Cryptogams.

A peculiar case of symbiosis occurs in the prothalli of *L. Phlegmaria*. Endophytic Fungi have already been described in prothalli of other species,* and here Dr. Treub finds the tissues constantly infested by a fungus, apparently one of the Peronosporeæ. Its thin filaments inhabit the interior of the cells themselves, but without killing them, the nuclei of the cells remaining normal, while the growth of the prothallus does not appear to be visibly hindered by its presence. It would appear that we have here a case of "commensal" symbiosis, in the strictly literal sense.

Rabenhorst's Cryptogamic Flora of Germany.—Parts 4–7 of the third vol. of this work continue the account of the ferns through the genera *Aspidium*, *Ceterach*, *Phegopteris* (*P. polypodioides*, *Dryopteris*, and *Robertiana*), and a part of *Aspidium*. The descriptions are carried out by Dr. Luerssen in great detail, many of the varieties being described, as well as the species. The woodcuts are excellent.

Muscineæ.

Microspores of Sphagnum.†—Herr C. Warnstoff confirms the old observation of Schimper of the occurrence of two kinds of spore in the Sphagnaceæ. The microspores he finds to have a diameter of 0·012–0·018 mm., in contrast to that of the ordinary spores, from 0·030 to 0·033. In *Sphagnum acutifolium* and *acutiforme* he found them in special microsporangia, either on separate plants from the macrosporangia or intermixed with them; in *S. Girgensohnii* in the same sporangium as the macrospores, and resembling them in every respect except size. He was unable to ascertain their function, or whether they are capable of germination.

Physiotium.‡—Herr J. B. Jack gives a complete monograph of this genus of Jungermanniceæ, comprising ten species, all tropical. Besides the inflated or vesicular character of the lower lobes of the leaves, the genus is characterized by the presence of peculiar tubular organs, either scattered over the ordinary branches or at the apex of special branches. Their function is unknown, but they may possibly be barren perianths.

* Cf. this Journal, v. (1885) p. 839.

† Hedwigia, xxv. (1886) pp. 89–92.

‡ Ibid., pp. 49–87 (10 pls.).

Algæ.

New Genera of Seaweeds.*—Herr H. F. G. Strömfelt describes several new species of seaweed from Iceland, and the following new genera:—

Hæmatostagon. Thallus crustam maculæ similem formans duobus stratis contextam: 1) basali, simplici, membranaceo, matrici arcte adhærente: 2) superiore, parenchymatico, cellulis in seriebus verticalibus admodum regularibus dispositis. Fructus ignotus. Belongs to Squamariaceæ.

Coilodesme. Thallus callo radicali affixus, inferne stipitiformis solidus, superne cavus, duobus stratis constructus, quorum interius e cellulis longitudinalibus membranis crassioribus, exterius e filis transversalibus subdichotomis cellularum parietibus lateralibus gelatinosis pseudoparenchymatice coalitis formatum; cellulæ filorum terminales endochromate largiore præditæ, in membranam epidermaticam arcte conjunctæ. Sporangia inter extrema filorum segmenta sessilia. Among Chordariaceæ.

Stragularia. Thallus crustam formans matrici arcte adhærentem strato basali simplici membranaceo fila verticalia emittente constructam, quorum e cellulis apicalibus demum paraphysæ et sporangia sorum indefinitum formantia exeunt. Among Lithodermateæ.

Zoospores of Chlamydomonas.†—M. Bréal has observed that the zoospores of *Chlamydomonas pulvisculus* are remarkably attracted by light, and that, with regard to the influence of rays of different colours, blue, green, and red exercise this attractive power, but not the yellow rays. The zoospores of *Chlamydomonas* remain for a long time in a dormant condition after becoming fixed and invested with cellulose before they germinate.

Cooke's British Desmids.‡—Dr. M. C. Cooke has issued four parts of his work on British desmids, with coloured plates and letterpress descriptions, uniform with his 'British Fresh-water Algæ.' It is hoped that the work will be completed in about ten monthly parts. Ralfs's 'British Desmidieæ' was published in 1848, and has long been out of print, so that it cannot now be obtained, except at a price beyond the reach of the ordinary microscopist, and even when obtained, would necessarily be deficient in all the species which have been found and identified during the past forty years. The book is one that has long been felt to be needed by pond-hunters. It may be expected to include about one-third more species than were figured in its predecessor. The current parts contain figures of *Gonatozygon*, *Sphærozosma*, *Onychonema*, *Hyalotheca*, *Bambusina*, *Desmidium*, *Docidium*, *Closterium*, *Penium*, &c. Measurements are given in milli-

* Naturvet. Studentsällsk. Upsala, March 16, 1886. See Bot. Centralbl., xxvi. (1886) p. 172.

† Bull. Soc. Bot. France, xxxii. (1886) pp. 238–9.

‡ Cooke, M. C., 'British Desmids. A Supplement to British Fresh-water Algæ,' with coloured plates. Parts I., II., III. and IV. 8vo, London, 1886, 64 pp. and 32 pls.

metres and micromillimetres, as determined by different observers, whose initials are appended, and all the figures are drawn to a uniform scale of 400 diameters, except in a few instances where further enlargement is necessary.

Formation of Auxospores in Rhizosolenia alata.* — Herr F. Schütt describes the formation of auxospores in this diatom which occurs in great abundance in the Baltic. It multiplies by division in the ordinary way in the spring and summer; the auxospores are found chiefly in August and September, and differ greatly in appearance from those of most diatoms, having been described by previous observers as distinct species or varieties.

When an auxospore is about to be formed, a slender mother-cell breaks up into two half-frustules. Through the opening thus formed in one of the half-frustules the protoplasm swells in the form of a capitulum, and excretes on the surface in contact with the water a silicified membrane which attaches itself to the old girdle-band, and thus becomes an auxospore. The capitulum elongates into a short cylinder, excretes on its inner side a shell, and thus becomes an augment-cell. This may form in succession a number of daughter-cells by the elongation and bipartition of the thick end; these are unlike the augment-cell, and differ from the mother-cell only in greater stoutness. The augment-cell itself may become transformed into a daughter-cell after having undergone a larger or smaller number of divisions. The daughter-cells are the starting-points of new generations which increase further by bipartition.

Fungi.

Acrogenous Development of the Spores of Fungi.† —M. J. de Seynes points out that the ordinary statement that the spores or conidia of fungi are formed exogenously by simple cell-division is not in all cases strictly correct. In a species of the genus *Sporochisma*, found on over-ripe pineapples, the spores are formed distinctly within the cell next lowest on the chain, from which they escape through a small orifice formed in the wall at the apex of the mother-cell. Spores which are ultimately developed acrogenously, and are termed acrospores, are here distinctly originally of endogenous origin.

Germination of Spores of Ustilago Vaillantii.‡—According to Sig. F. Morini, when the spores of this fungus germinate in rain-water, they put out short and but slightly branched germinating tubes; while in spring-water which contains mineral salts and organic substances, they give out one long and branching tube from each pole. In a drop of nutrient solution, such as a decoction of the flowers or leaves of *Bellevalia romana*, the germinating spores form short simple tubes, which multiply abundantly by budding; these develope ovoid

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 8–14.

† Comptes Rendus, xcii. (1886) pp. 933–4. Cf. this Journal, *ante*, p. 488.

‡ Mem. R. Accad. Sci. Ist. Bologna, vi. (1885) 9 pp. (1 pl.). See Bot. Centralbl., xxvi. (1886) p. 209.

or elliptical spore-like structures at their apices when the nutrient substratum begins to be exhausted.

Glycogen in Fungi.*—M. L. Errera recapitulates the microchemical tests by which he has determined the presence of glycogen in certain fungi, among which he names *Peziza vesiculosa*, *Tuber melanosporum*, *T. æstivum*, *Phycomyces nitens*, *Clitocybe nebularis*, and *Phallus impudicus*. He believes this substance to be generally distributed through the Ascomycetes, Mucorini, and Basidiomycetes, and to be used up in the formation both of the tissues and of the spores.

Laticiferous System of Lactarius.†—Prof. A. Weiss describes in detail the segmented latex-vessels in the receptacle of *Lactarius deliciosus*. He finds them to be true vessels formed by the fusion of cells, such as were supposed to be confined to the higher plants. The mature laticiferous vessels are of considerably larger diameter than the ordinary hyphæ of the stipes and pileus; they branch copiously, but the different tubes do not in any way coalesce or form an anastomosing network; they are segmented by septa, especially in the neighbourhood of the branches. They are so densely packed that there may be as many as 400–500 in a square mm., and are most numerous in the peripheral layers of the stipes and in the medullary tissue; in the sub-hymenial layer they are at first altogether wanting. Even when mature a nucleus is to be recognized in them without difficulty.

Development of the Receptacle of Phalloideæ.‡—M. E. Fischer describes the development of the receptacle in *Ithyphallus tenuis*, *I. rugulosus*, *Dictyophora campanulata*, and *Mutinus bambusinus*. He distinguishes four types, viz. (1) *Mutinus;* (2) *Ithyphallus tenuis* and *impudicus;* (3) species with an involucre (*Dictyophora*); and (4) *Kalchbrennera*. He regards the species with an involucre as showing a distinct affinity with the Agaricini provided with a volva.

New Sphæriaceæ.§—M. C. Richon describes a number of new species of fungus belonging to the Sphæriaceæ, among them a fossil form from the tertiary formation in the neighbourhood of Rheims, which he calls *Leptosphærites Lemoinii*. Also a new genus of recent forms, *Lophiotricha*, with the following diagnosis:—Perithecia simplicia, innato-superficialia, carbonacea, nigra, strigoso-pilosa, villo concolori ad basin ut plurimum cincta; ostiolo compresso, cristato, setulis rectis obsita. Asci elongati, paraphysati, octospori. Sporidia disticha, fusoidea, elongato-bilocularia, ad septum leniter constricta, hyalina. The typical species, *L. Viburni*, was found on dead branches of *Viburnum Lantana*.

Polymorphism of the Hypocreaceæ.‖—Dr. O. Mattirolo has examined the "mycorhiza" on the roots of the chestnut, and finds

* Bot. Ztg., xliv. (1886) pp. 316–20. Cf. this Journal, v. (1885) p. 503.

† SB. K. Akad. Wiss. Wien, xci. (1885) pp. 166–202 (4 pls.).

‡ Ann. Jard. Bot. Buitenzorg, vi. pp. 1–51. See Bot. Centralbl., xxvi. (1886) p. 130.

§ Bull. Soc. Bot. France, xxxii. (1885) Sess. Extraord., pp. viii.–xii.

‖ Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 121–54 (2 pls.).

among it two new species of Hypocreaceæ, which he names *Melanospora stysanophora* and *M. Gibelliana*. The commoner form in the cycle of development of the former is *Stysanus Steminotis*. Its spores, when cultivated, always give rise to *Acladium* and *Stysanus* through a number of generations, and only in a few cases produce perithecia. The *Melanospora* includes, in its cycle of development, two conidial forms, *Acladium* and *Stysanus*, the former again also reproducing the conidial form on cultivation, while the spores of *Melanospora* produce the three typical forms. He concludes that while many Ascomycetes present the phenomenon of apogamy, we have, in this species of *Melanospora*, an example of *apandry*, or the production of ascospores independently of the previous formation of a male organ.

Melanospora Gibelliana produces on its mycelium abundance of the singular bodies described under the name of "spore-bulbils." They appear to replace the true ascophorous perithecia, and consist of one or more cells, containing abundance of protoplasm, and surrounded, as by an involucre, by other dusky cells destitute of chlorophyll. On germinating they reproduce the same form. Mattirolo also observed the peculiar kind of spore described by Eidam as *chlamydospores*.

Alternation of Generations in the Uredineæ.*—M. M. Cornu records a fresh instance of this phenomenon not previously known. In addition to the common rust on the leaves of the pine due to *Peridermium Pini*, identical with *Coleosporium Senecionis*, there is another rust found on the bark, generally regarded as a variety of the former. This occurs in situations where no species of *Senecio* is to be found, and M. Cornu has succeeded in connecting it genetically with *Cronartium asclepiadeum*, found on *Vincetoxicum officinale*. No æcidial form had hitherto been known of any species of *Cronartium*.

Uredineæ parasitic on Rosa and Rubus. †—Herr J. Müller enumerates the Uredineæ hitherto known as parasitic on different species of *Rosa* and *Rubus*, viz. on *Rosa* :—*Phragmidium subcorticium* (on several species), and *P. Rosæ alpinæ* ; and on *Rubus* :—*P. violaceum*, *P. Rubi*, *P. Rubi Idæi*, and *Chrysomyxa albida*. To these he now adds the two following new species :—*Phragmidium tuberculatum* on *Rosa canina* and *cinnamomea*, and *Uredo æcidioides*, on *Rubus*. Two other new species are also described, viz. *Fusarium spermogoniopsis* and *F. urediniicola* both parasitic on other Uredineæ, themselves parasitic on *Rosa* and *Rubus*, the former on *Phragmidium subcorticium* and *P. Rubi*, the latter either on these parasites or on their hosts.

Pine-destroying Fungi and Insects. ‡—M. Lindemann describes the rapid destruction of pine-trees through the combined attacks of a fungus and an insect. The root-like processes or rhizomorphs of *Agaricus melleus* penetrate the roots of the pine and mount up the stem,

* Comptes Rendus, xcii. (1886) pp. 930–2.

† Ber. Deutsch. Bot. Gesell., iii. (1886) pp. 391–5.

‡ Arch. Slav. de Biol., i. (1886) pp. 223–4, from Bull. Soc. Imp. Nat. Moscou, 1885.

which then exhibits a copious exudation of resin. The mischief is greatly increased by the appearance of a beetle (*Tomicus typographus*) which riddles the tree with its galleries. The combined attack rapidly results in the death of the tree. M. Lindemann advises the cutting down of the tree, and the isolation of its roots by trenching.

Fungus-parasites of the Vine.*—M. E. Prillieux finds the roots of vines affected by "pourridié" to be densely infested by two parasitic fungi, *Rœsleria hypogæa* and *Dematophora necatrix*. The roots covered with the former fungus in a state of fructification are in no way infested by the latter.

New Parasitic Fungi on Corn.†—Dr. F. Morini has found a field of wheat in the Bolognese territory, in which the leaf-sheaths were spotted with black confluent streaks, and the lamina yellow and withered. They proved to be attacked by parasitic fungi, the greater part of the damage being done by two new species which are described at length:—*Sphærella exitialis* and *Septoria Briosiana*.

Parasitic Fungus on Forest Trees.‡—Sig. A. N. Berlese describes and figures a little-known fungus widely distributed throughout Europe, and parasitic on the poplar, willow, walnut, ash, maple, elm, oak, mulberry, horse-chestnut, *Robinia Pseudacacia*, &c. It is the *Lophiostoma Balsamianum* Ces. and De Not., which he identifies with *L. excipuliforme* Fr. and with *Sphæria excipuliformis* Berk. and Br.

Polystigma fulvum, a new Almond Disease.§—M. M. Cornu records this fungus for the first time as the cause of a disease in almond trees. It attacks the leaves, on which it causes brown-orange spots. When these leaves fall to the ground, the red stroma becomes black, and developes ascophorous conceptacles, as in the case of *P. rubrum*.

Intramolecular Respiration and Fermentation of Moulds.‖—From experiments on *Penicillium glaucum*, *Aspergillus niger*, and *Mucor stolonifer*, Herr N. W. Diakonow concludes that the formation of carbon dioxide when no free oxygen is present is no universal property, under all conditions, of living cells, but is dependent on the specific nutrient substance; moulds can maintain this formation of carbon dioxide only when supplied with glucose. When supplied with non-fermentive substances, or with those which are the best nutrients with access of oxygen, the formation of carbon dioxide ceases entirely as soon as the supply of oxygen is withdrawn. The evolution of carbon dioxide by moulds in an atmosphere destitute of oxygen ceases at once on the withdrawal of the glucose of the external nutrient substance, although it may contain a substance which is serviceable for normal respiration. When there is no free oxygen, the carbon dioxide does not result from the decomposition of the albuminoids. Glucose, as a fermentive nutrient, is alone capable of

* Bull. Soc. Bot. France, xxxiii. (1886) pp. 36–7.
† Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 32–43.
‡ Ibid., pp. 43–52 (1 pl.). § Comptes Rendus, xcii. (1886) pp. 981–3.
‖ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 2–7.

furnishing the oxygen necessary for the metastasis of moulds in an atmosphere destitute of oxygen. Whether free oxygen is present or not, the energy of the metastasis of fungi is increased by the supply of peptone in nearly uniform proportions. Fermentation (or intramolecular respiration) supports the metastasis of the living organism, and consequently its life, when there is no free oxygen; and this explains the rapid death of fungi without evolution of carbon dioxide, in an atmosphere destitute of oxygen, as well as the difference in the duration of life with evolution of carbon dioxide, according to the fermentive capacity of the fungus. When the supply of nutrient material is deficient, the activity of respiration gradually declines, even when oxygen is present, to a very low point, without resulting in the death of the fungus. The intensity of the formation of carbon dioxide by moulds in an atmosphere destitute of oxygen falls with the increase in the acidity of the saccharine nutrient substance, while normal respiration is almost unaffected by this circumstance.

Protophyta.

Microbes of the Soil.*—M. E. Laurent has made some experimental researches on the utility of microbes of the soil for the growth of higher plants; he made four sets of observations, with natural soil, with earth sterilized and then inoculated with bacteria of the soil, with sterilized earth, and with the same to which certain chemical compounds were added. The third series was, from every point of view, found to be inferior to the others; the second gave a few more flowers and fruits than the first. The whole show the utility of microbes in arable land rich in organic detritus. Henceforward, the author thinks, agricultural chemistry will have to occupy itself with the biological properties of the bacteria which are found in the earth. The microbes appear to be of use in decomposing the detritus of dead plants on which their successors live, but which they are unable to assimilate until it has been broken up for them.

New Pathogenic Micrococcus.†—Dr. L. Manfredi has found, in the sputum of two cases of crupose pneumonia, besides Friedländer's pneumococcus, constantly a micrococcus which presents several distinguishing features; but he has not been able at present to determine any causal connection between it and the disease. The micrococci are ovoid, 1·0–1·5 by 0·6–1·0 μ in diameter, solitary or united in pairs, less often in chains of three or four. It subsists in all the ordinary vegetable substrata, and it is produced with special rapidity in contact with the air. Its development is intracellular, producing caseous necrosis of the elements. When animals are inoculated with it, it takes possession especially of the spleen and of the lymphatic ganglia; it possesses intensely infectious properties.

* Bull. Acad. R. Sci. Belg., lv. (1886) pp. 128–43.
† Atti R. Accad. Lincei, i. (1885) pp. 825-8.

MICROSCOPY.

a. Instruments, Accessories, &c.*

Nachet's Large Microscope.—The modern form of M. A. Nachet's larger Microscopes is very familiar to English microscopists, and in the latest modification of the "Grand Modèle perfectionné" all the leading features are retained. The modifications relate principally to (1) the fine-adjustment, (2) the substage, (3) the mirror, and (4) the stage.

The *fine-adjustment* is on the well-known Continental model, but the action of the spiral spring is reversed, that is, it is now arranged to draw the sheath connected with the body-tube *downwards*, instead of pushing it upwards as formerly; by this alteration the fine-adjustment screw controls the movement by the contact of its point with a hardened steel plate, greatly reducing the friction, whereas formerly the screw passed through a nut against which the spiral spring pressed upwards, causing much friction. The result is claimed to be "a precision and smoothness quite remarkable," with, at the same time, complete rigidity in consequence of the extent of the surfaces of contact in the prismatic column, so that the second (Jackson) slow motion of the older form is not required.

The *substage* is centering, and to change the condensers, &c., can be turned back from the stage on a pivot, which can also be removed when required, being attached to a short arm sliding in grooves in the tail-piece and moved up and down by a lever. The pivot contains a slow motion, allowing the illumination in the substage to be focused very exactly on the object.

The *mirror* is attached by a series of short arms with three articulations acting at right angles to each other, so that it can be moved in all directions for obtaining the effects of oblique light. Its distance from the stage can also be varied.

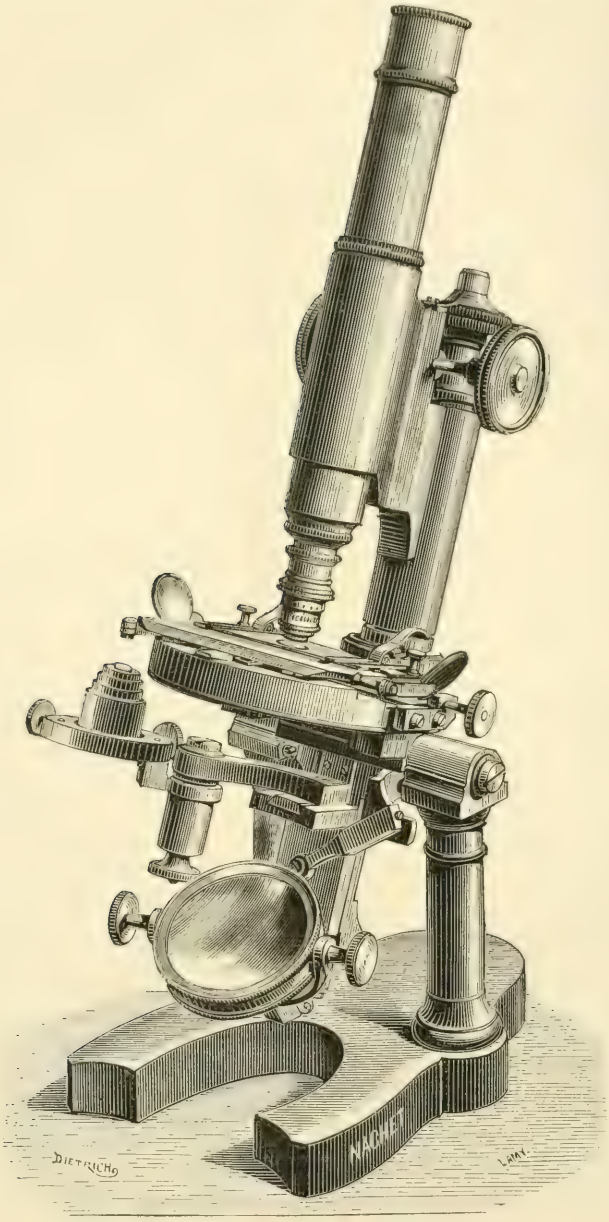
The modification of the *stage* is, however, the most striking of the novelties, as it comprises an arrangement for observing the approach of the objective to the cover-glass. It is thus described by M. Nachet†:—

"To the stage can be adapted at pleasure an arrangement which is very useful in the examination of rare or precious slides. It is composed of two small mirrors, one concave, placed at the level of the stage on the left, and movable in all directions, so as to send rays of light grazing the surface of the stage. The second one (plane) is placed opposite on the right, and is inclined at 45°, so as to deflect the rays vertically. The image of the end of the objective brightly illuminated is received on the small mirror on the right, and at a

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

† 'Catalogue descriptif des Instruments de Micrographie construits par A. Nachet,' 64 pp., 72 figs., 2 heliographs, and 1 col. pl., 8vo, Paris, 1886.

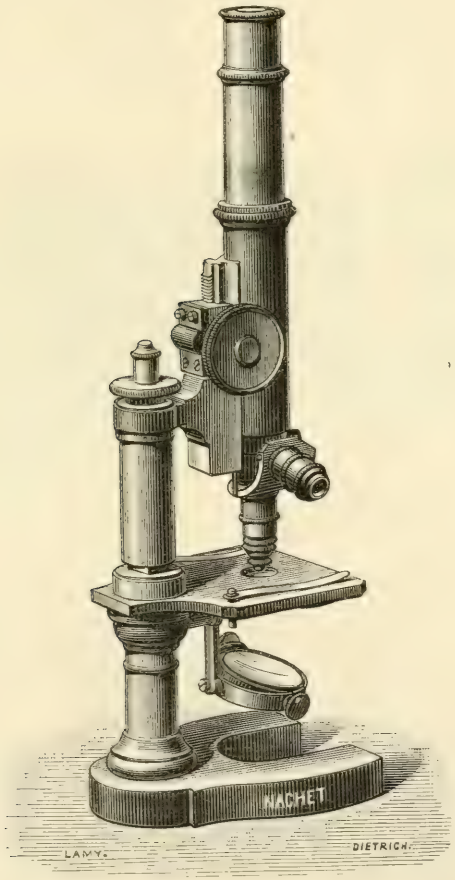
Fig. 157.



Nachet's Large Microscope.

glance it can be seen whether it is in contact or not. The layer of immersion liquid allows the grazing rays to pass even when the first lens is nearly in contact with the slide. This arrangement is very useful, and will be popularized more and more as an adjunct in the use of very high power objectives."

Fig. 158.



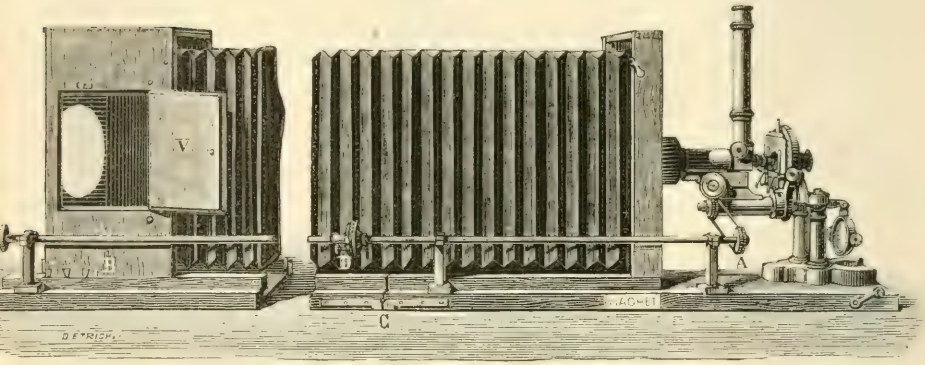
Nachet's Microscope with fixed Revolver for Objectives.—This Class Microscope (fig. 158) represents another attempt * to cope with the tendency of French students to unscrew the objectives of Micro-

* See this Journal, v. (1885) p. 514.

scopes placed in their hands [" instrument très solide pour être mis entre les mains des élèves et éviter le dévissage des objectifs" *]. The objectives are attached to a revolver so that they cannot be unscrewed, neither can the lens-cells be removed. The revolver consists of an angle-plate shaped like a sector and suspended in front of the body-tube to swing on its centre, so that either objective can be brought to the axis of the body-tube. The brass mounts of the objectives are so arranged that the foci are approximately in the same plane.

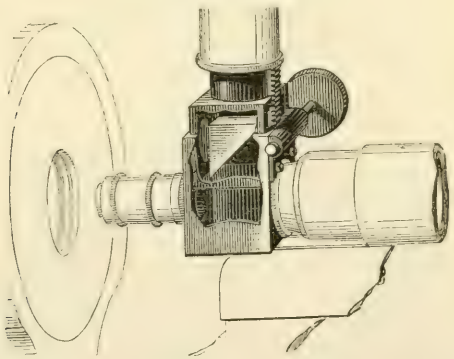
Nachet's Photo-micrographic Microscope.—M. Nachet's Micro-

Fig. 159.



scope and camera complete are shown in fig. 159, and an enlarged view of part of the Microscope in fig. 160.

Fig. 160.



The Microscope has a special arrangement for allowing the image to be viewed in the eye-piece previous to its projection on the ground

* Op. cit., p. 17.

glass, thus facilitating the adjustment of the illumination, the arrangement of the object, &c. This consists of a rectangular box containing a total reflecting prism, which can be raised or lowered by rack and pinion. In the former case the rays will pass to the camera, and in the latter are reflected upwards through the subsidiary body-tube.

The projection apparatus consists of a substantial wooden base, having grooved flanges near the edges on which a bellows camera B, extensible to upwards of 6 feet in length, is fitted to slide smoothly.

The Microscope is placed at the free end of the base and in a horizontal position; the body-tube is then connected with the front of the camera by adapter-tubes of special construction, by which the focusing movements of the Microscope are not interfered with, and at the same time all extraneous light is shut out at the junction. The milled head of the fine-adjustment screw is provided with a groove in which travels a cord connecting it with a grooved wheel A, to which a rod F D (jointed at D) is attached, so that the focusing can be actuated by the milled head at F, i. e. from the extreme length of the camera.

For the general class of photo-micrographic work the camera is not required to be more than about half the total length of its extension; to reduce it, the end B is slid forward on the base within C, the focusing rod is divided at D, the portion F D being removed, together with the pillar support below F, and the hinge C then permits the tail-piece of the base to be folded beneath the front part, and fixed by hooks at either side.

For focusing, the image is received on the ground glass and viewed in the usual manner, or a sheet of white cardboard is substituted for the ground glass and the image is viewed through the opening at the side V.

This plan of substituting a piece of white paper for the ground glass is one that is very little used in England. It was, we believe, originally suggested by M. Moitessier,* and was applied in the first instance to a vertical camera and Microscope where the height of the ground glass above the stage rendered it difficult to manipulate, but by adding the box at the end of the bellows, the observer was able to focus from the side, looking *up* at the image, and also to dispense with the equally inconvenient use, in M. Moitessier's opinion, of long rods or similar arrangements for focusing. In his view, also, paper is decidedly preferable to ground glass, "the grain of which gives rise to diffraction phenomena, which are extremely objectionable, and which often prevent the proper focusing of delicate objects." "With the paper the image will always be much sharper than when seen after transmission through ground glass, and the adjustment for focus can be made much more precisely and conveniently."

* A. Moitessier, 'La Photographie appliquée aux recherches micrographiques,' 1866, pp. 128–9.

Nachet's Photographic Microscope for Instantaneous Photographs.—This (fig. 161) is an ingenious arrangement for taking instantaneous photographs of living microscopic animals, and is based on the principle of M. Nachet's double-bodied Microscope.

Over the objective (fig. 162) is placed a prism, which prevents

Fig. 161.

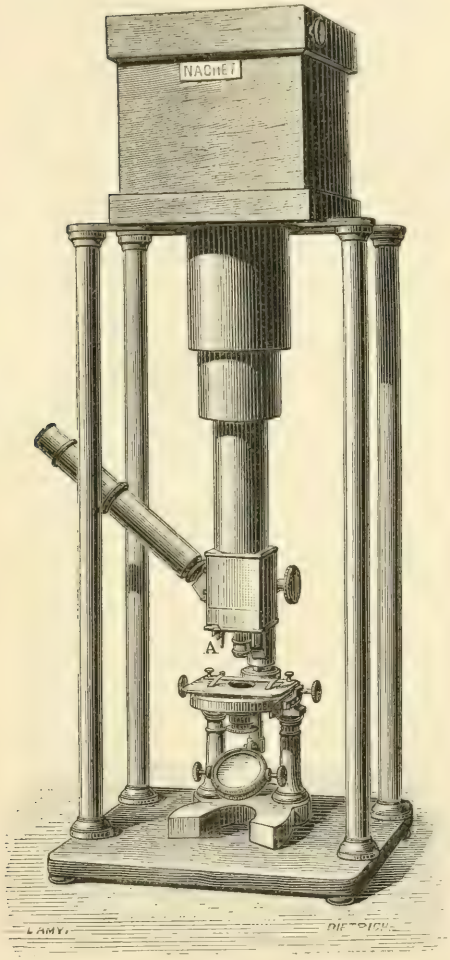
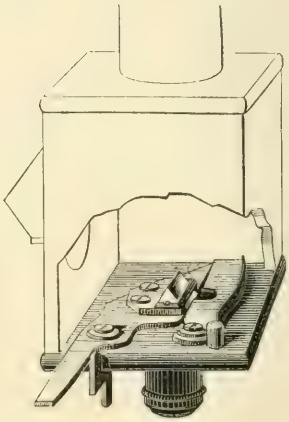


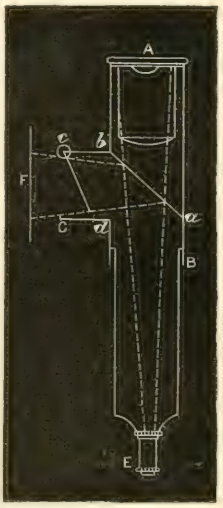
Fig. 162.



any of the rays from the object passing to the camera (which is supported on four pillars above the Microscope), and diverts them into the inclined body-tube fitted with an ordinary eye-piece. The

observer keeps his finger on a trigger A acting on the spring lever to which the prism is attached, and at the right time moves the prism on one side by a slight pressure, allowing the image to pass to the camera for a fraction of a second, the prism falling back again into its place.

Fig. 163.



By a special contrivance in the body-tube each observer can regulate his focus once for all, so that whenever the image is sharp as seen through the eye-piece it is at the same time exactly focused on the sensitive plate.

This is a better plan than that of M. Bourmans,* who endeavoured to "photograph a fugitive object, observing it at the same time throughout the whole duration of the exposure" by the arrangement shown in fig. 163. A B is a vertical tube having a horizontal side-tube C. The body-tube with objective E moves freely in A B. At *a b* is placed a plane plate of glass silvered on its lower surface with a very thin layer of silver. This will reflect 75 per cent. of the rays to the sensitive plate F placed at the end of the short side-tube C, and at the same time sufficient light will be transmitted through the plate to enable the observer to keep the object under observation through the eye-piece A. At *c d* is a shutter which is kept closed until the focus is adjusted, when it can be raised by turning the button at *c*.

Fuess's Petrological Microscopes.—Herr R. Fuess has considerably modified his Petrological Microscope, which now has the form of fig. 165.†

The body-tube has two openings, one at *k* for the insertion of the Bertrand lens *f*, and the other at N for the analyser. The lens is attached to the draw-tube R, which can be raised and lowered by rack and pinion at T; the plate *g* is a stop, which prevents it from being drawn out of the tube unless extra pressure is used, when the plate will spring a little and allow the lens to pass.

The analyser N is attached to the plate *o o*, by which it slides in or out of the tube as desired. An analyser S can be applied over the eye-piece, and a quartz plate, &c., inserted in the slit above the objective, which can also be centered.

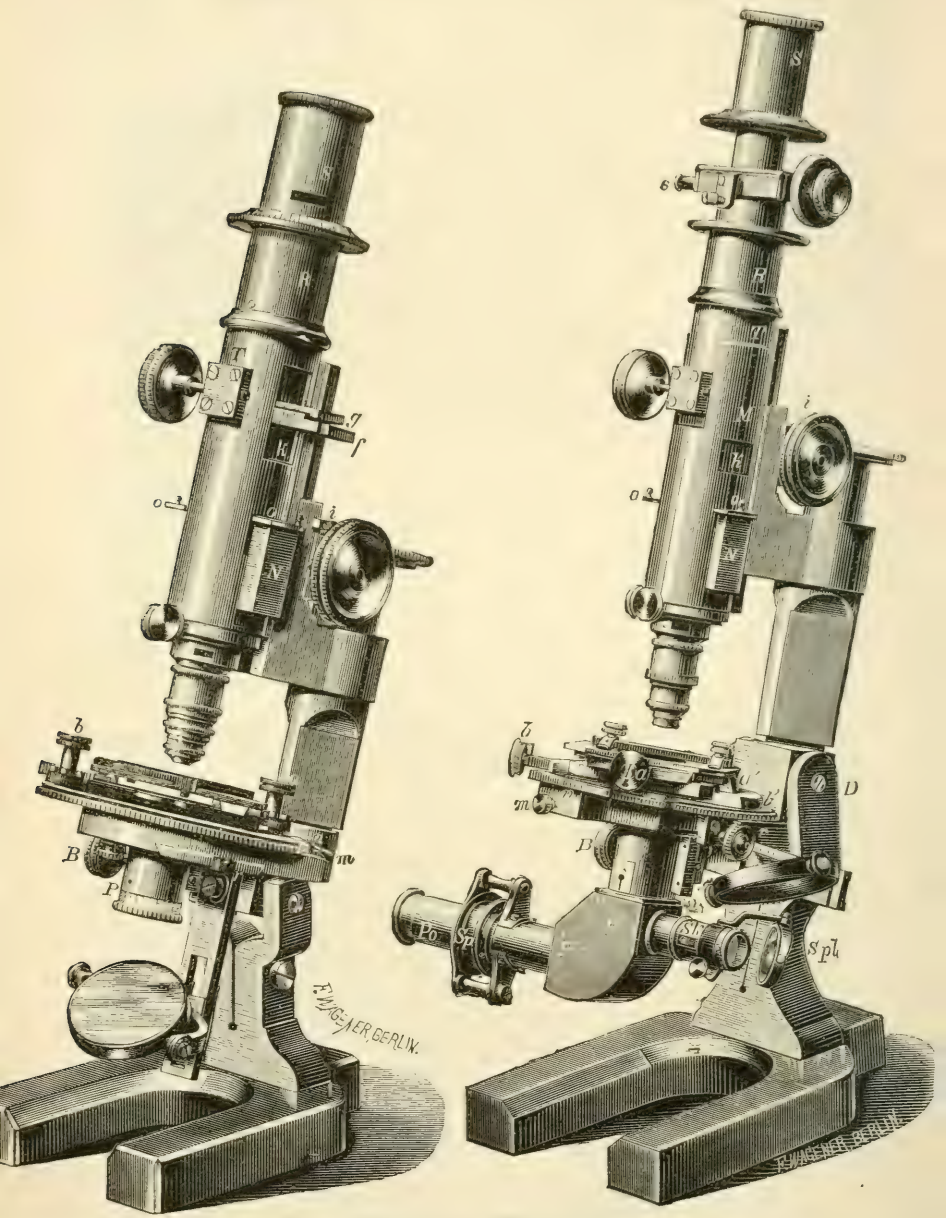
The polarizer P has a rack-and-pinion motion B, and the milled head of the fine-adjustment is graduated and reads against an index *i*.

To the rotating stage-plate is applied a mechanical stage with

* Cf. Girard's 'La Chambre noire,' 1870, pp. 58–60 (1 fig.).

† Cf. Rosenbusch's 'Mikroskopische Physiographie,' 2nd ed., 1885, i. pp. 562–4 (2 figs.).

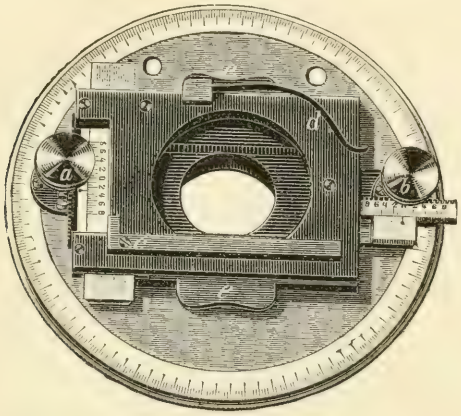
Fig. 164. Fig. 165.



Fuess's Petrological Microscopes.

finders, shown in fig. 166, in which the milled heads *a b* for the rectangular movements are placed within the circumference of the

Fig. 163.



stage. There are two verniers, one of which is shown at *n* (fig. 164). The rotation of the stage can be stopped by the arm *m*.

Fig. 167.

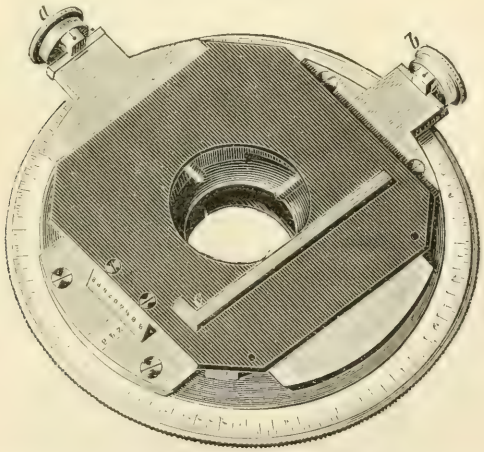
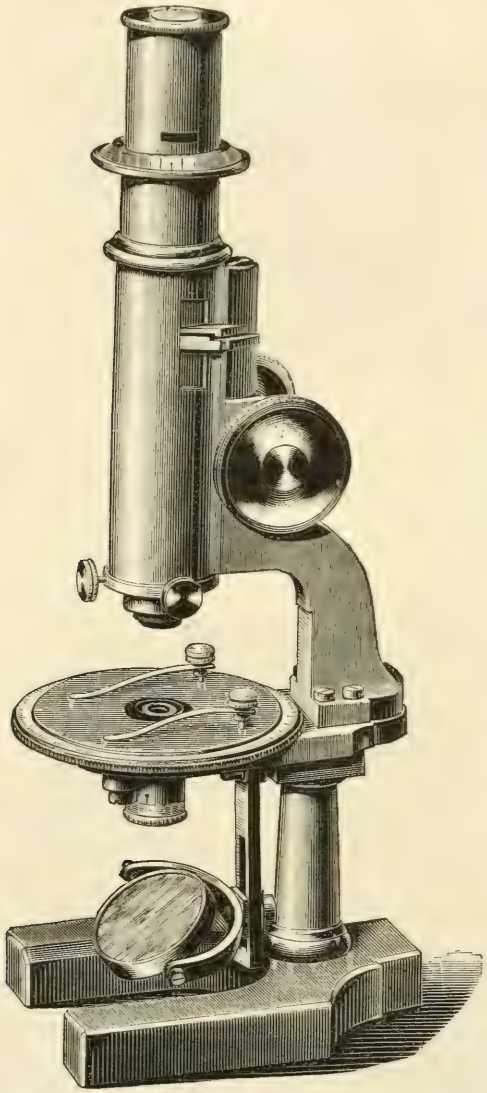


Fig. 165 is substantially the same form of instrument with a screw micrometer eye-piece *s* and an Abbe spectro-polarizer (Po, Sp, P, Sk, Spl).

The stage for this form is shown in fig. 167.

Three other simpler forms are made by Herr Fuess, the simplest of which is fig. 168.

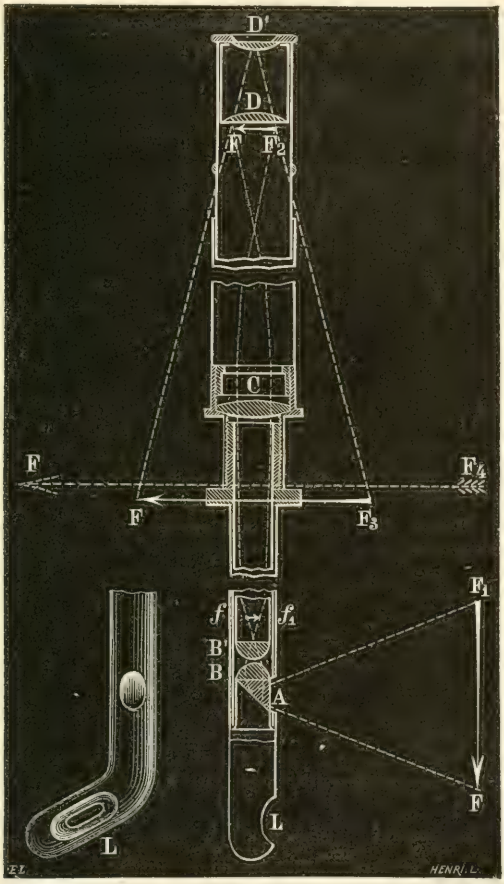
Fig. 168.



Fuess's Petrological Microscope (Simple Form).

Electro-megaloscope.*—M. E. Dieudonné describes and figures Dr. Boisseau du Rocher's Megaloscope for examining the stomach, bladder, and other internal cavities. A full translation of the original article having been already given,† we need only add the description of fig. 169, which shows the apparatus for examining the bladder.

Fig. 169.



At the lower end of the tube is a lateral aperture closed by a right-angled prism A. Above the prism are two hemispherical lenses B B′ with the convex surfaces turned to each other. A diminished image of an object F F_1 is formed at $f f_1$ which serving as an object to the lens C in the upper part of the tube, a second, still diminished, image is formed at F F_2. This gives with the Ramsden eye-piece D D′ an image F F_3, a little larger than the original object.

* La Lumière Électrique, xix. (1886) pp. 64–7 (3 figs.).
† See this Journal, v. (1885) p. 1061.

A stronger eye-piece would give a larger image, as at F F_4.

The lower part of the tube, which carries at L the incandescent electric light, is shown in perspective as well as in section.

Cramer's Movable Stage.*—Dr. C. Cramer's movable stage (figs. 170 and 171), is described with a wealth of detail which seems inseparable from the descriptions of similar apparatus by Continental writers. It fits over the fixed stage, and acts as a finder.

Fig. 170 shows the apparatus as seen from above. It is so fitted to the stage that the screw S is at the right hand of the Microscope.

Fig. 170.

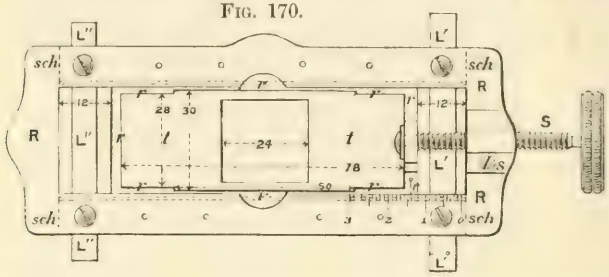
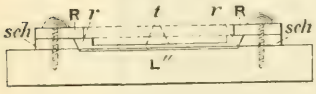


Fig. 171 is a section as seen from the left end. The apparatus consists of a frame R of lacquered brass about 14 cm. long and 2·5 mm. thick, the long sides of which are bowed out in the middle to prevent any collision between the objective and the frame. The two cross-pieces L′ L″ project over the edge of the stage, so that the apparatus can be pushed forwards and backwards as required. L′ is the longer of the two and has a line and letter *o* marked on its lower end. This index is intended to be used in conjunction with a millimeter scale on the edge of the stage. The cross-pieces L′ and L″ are not united directly to the frame R, but by means of two rectangular brass slips; the dotted lines *sch* fig. 170 show their extent in horizontal projection, and fig. 171 gives them in section, and shows that they slope inwards and downwards, forming a kind of groove for the reception of a slide, moving parallel to the long axis of the apparatus. This slide consists of a blackened brass plate *t* not more than 1/2 mm. thick, provided in the middle with a square opening, the sides of which are 24 mm. long. It is stiffened with a thin blackened framework *r*. The long side pieces of the frame *r* are sloped inwards so as to fit accurately in the groove. The slide is therefore firmly held in its movements to and fro. According as the screw S is turned one way or the other the slide *t* will be moved to the right or the left, the extent of the movement being 24 mm., the width of the quadrangular central aperture.

Fig. 171.



* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 5-14 (2 figs.).

To mark the place of any small object it is merely necessary to read off the number on the millimeter scale, fig. 170. This gives what may be termed the movable ordinate. The fixed ordinate is obtained by keeping the line —° on L′ at a prearranged point, or by having another millimeter scale marked along this side of the stage. Thus any spot in a specimen can always be found at once.

The object of the central widening of the frame *t* is for the admission of slides of the "Giessener Format." The longer length and shorter breadth of *t* are for slides of the English and Vienna sizes.

Zeiss's Apochromatic Objectives, Compensating Eye-pieces, and Projection Eye-pieces.—As a rule we do not notice in the Summary the catalogues or price lists of manufacturers, but the catalogue just issued by Dr. C. Zeiss * of the new objectives and eye-pieces, contains so much interesting as well as useful information for microscopists that we reproduce it nearly *in extenso*.

Apochromatic Objectives.—In the construction of the objectives thus designated, new kinds of glass and a greatly improved method of correction have been employed, with the result that the secondary spectrum is removed, and the spherical aberration uniformly corrected for the different parts of the spectrum. There is, therefore, a much more perfect concentration of the rays in the image than with the best objectives hitherto made, and in the case of the chemically effective rays, there is neither focal difference nor spherical aberration.

They also allow very high eye-pieces to be used without detriment to the accuracy or brightness of the image, thus giving high magnifying power with relatively long focal length, and enabling a series of very varying amplifications to be obtained with the same objective.

The natural colours of objects, even in the more delicate tints, are reproduced unaltered by these objectives, in consequence of the very slight intensity of the residual tertiary spectrum.

The differences in the amplification of the image for the various colours are reduced to the same amount in all the objectives, and are removed by the compensating eye-pieces hereafter described. The images therefore are uniformly free from colour throughout the whole field of view.

The spherical aberration outside the axis is so completely corrected that the sharpness of outline existing in the centre of the field of view is maintained almost up to the margin, although the focal adjustment between the centre and margins is necessarily somewhat different in consequence of the unavoidable curvature of the surface of the image.

The construction of each objective is based on calculations which extend to the smallest details of optical action. Every element—radii of curvature, thickness, diameter, and distance of the lenses from one another—are all accurately adjusted and numerically determined for each objective, with regard to the spectrometrical constants of the various kinds of glass employed, and the numerous conditions which have to be simultaneously fulfilled. The technical execution is

* Zeiss, C., 'Neue Mikroskop-Objective und Oculare aus Special-Gläsern des Glastechnischen Laboratoriums (Schott and Gen.),' 14 pp., 8vo, Jena, 1886.

carried out exactly on the data furnished by these calculations, with the strictest check on all the elements in the various stages of manufacture, and without any subsequent empirical touching up.

In the list given below the objectives are arranged according to their aperture. In the second column are the different focal lengths, while the third column gives the corresponding amplification obtained with the objective (the quotient of the conventional distance of distinct vision, 250 mm., divided by the focal length of the objective).

The objectives are constructed according to order, either for the Continental tube-length of 160 mm. or for the English of 250 mm. (or 10 in.). The three dry objectives of 6, 12, and 24 mm. focal length are, however, made exclusively for the English tube-length, as these objectives are not adapted for the Continental form. The tube-length is measured from the upper surface of the setting of the objective to the upper margin of the body-tube on which the eye-piece rests.

Great care must be taken to preserve the correct tube-length, as any deviation materially injures the performance of the objectives, particularly those for homogeneous immersion.

The settings of all the objectives are engraved with the name of the firm and also with the aperture, focal length, and length of the body-tube, for which they are adjusted. In ordering it is desirable that these three points should be specified so as to avoid any mistake as to the particular objective required (thus: Apochrom. 1·30, 2·0 mm., short tube).

The apertures given are the guaranteed minimum values; the real aperture is nearly always rather higher. The focal lengths are exactly as stated.

Apochromatic Objectives.

	Numerical Aperture.	Equivalent Focal Length in mm.	Objective Magnification for 250 mm.
Dry	0·30	24·0* 16·0	10·5 15·5
	0·60	12·0* 8·0	21 31
	0·95	6·0* 4·0	42 63
Water-Immersion ..	1·25	2·5	100
Homogeneous-Immersion	1·30	3·0 2·0	83 125
	1·40	3·0 2·0	83 125

The dry objectives of 0·95 aperture and the water-immersions are always provided with correction collars. The divisions on the

* See *supra*, lines 8–12.

collar give the thickness of cover-glass in hundredths of a millimetre. The correction for the proper thickness of cover must always be carefully made when using these objectives, or otherwise there will be a considerable falling-off in their performance.

The homogeneous-immersion objectives are only supplied in fixed settings as any alteration in the distance of their lenses interferes with the perfection of the correction. Slight variations in the thickness of the covers from the medium value (0·16 mm.) for which the objectives are corrected, have no influence on the image, but considerable variations should be compensated for by slightly lengthening the body-tube with thinner covers and shortening it with thicker ones.

The slightly thickened cedar oil (n D = 1·515) accompanying the objectives (and to be obtained at any subsequent time) should alone be used. Other substances should not be employed unless measurements of the refractive index and dispersion show exact correspondence with it. Mixtures of fennel oil and such like endanger the objectives.

To meet the desire for the highest possible objective-magnification, the homogeneous-immersions are also made with a shorter focal length of 2 mm., as well as with one of 3 mm., although it must still be regarded as an open question whether any decided advantage can be gained by the former. The impassable barrier to the increase of useful magnifying power which is fixed by the limit of aperture at present attainable, can already be reached, without loss, by an objective of the focal length of 3 mm., as the latter objective will bear the application of correspondingly higher eye-pieces without any appreciable detriment to its performance.

The objectives (homogeneous-immersion) of 1·30 aperture have so great a working distance that they will work through covers more than 0·30 mm. in thickness. With an aperture of 1·40 the working distance is reduced to 0·25 mm. These objectives require very careful handling, because in order to obtain the larger aperture the metal setting of the front lens has to be turned extraordinarily thin so that any blow or strong pressure upon the front of the objective is likely to injure it. For both reasons, therefore, the objectives with the slightly lower aperture are undoubtedly more convenient for regular use. The larger aperture will, however, of course allow of a rather higher degree of optical performance being reached.

No attempt is made to exceed an aperture of 1·40, as the small percentage of possible increase would render the objectives almost valueless for any scientific investigation.

With regard to the prices of the objectives, which, especially in the case of the dry series, may appear to be very high in comparison with the usual charges, it must be borne in mind that the apochromatics are far more complicated in their construction, and if their special qualities are to be maintained they must be far more difficult to manufacture than the ordinary objectives. Moreover the number of such objectives manufactured must be extremely limited, even with the resources of a large factory. The objectives, however, like all productions of our firm, stand on an absolutely free basis. The glass

employed is, by our own instrumentality, accessible to any one, and no optician is in the least degree prevented from producing the same objectives as good and as cheap as he can.

Compensating Eye-pieces.—These new eye-pieces have been designed for the purpose of compensating certain errors in the image formed by the objective, outside the axis, which cannot be corrected in the objective itself. They are specially arranged for use with the apochromatic objectives, and materially improve their performance by giving a uniformly colourless image.

The eye-pieces may also be effectively used with relatively wide-angled objectives of the old form, but when used with the ordinary medium and low power dry objectives, the images which they give outside the centre of the field are inferior to those obtained with the eye-pieces hitherto used. On the other hand, the apochromatics of 0·95 and upwards allow of the use of ordinary eye-pieces without any material detriment to their performance. The dry objectives of 0·60 and 0·30, however, are absolutely dependent on the compensating eye-pieces; if used with the ordinary ones the images will be confused by colour-fringes.

The compensating action of the eye-pieces on certain chromatic aberrations in the objective-image, can be well seen with the higher powers where the diaphragm limiting the field of view is outside the lenses. The edge of this diaphragm will be found to show a deep red border, whilst when used with the apochromatics the image remains quite colourless up to its margin.

The classification of these eye-pieces is carried out on the principle suggested by Prof. Abbe, viz. on the increase in the total magnifying power of the Microscope obtained by means of the eye-piece as compared with that given by the objective alone. The ratio of the magnification obtained with an eye-piece and a given body-tube, to the real magnification of the objective itself (or in other words, the number which denotes how many times an eye-piece increases the magnifying power of the objective, when used with such a body-tube) gives the proper measure of the eye-piece magnification, and at the same time the figures for a rational numeration.

On this basis the series of eye-pieces is arranged according to their magnifying power:—

1 2 4 8 12 18 27

the figures serving at the same time as the designation of the eye-pieces.

The magnification obtained by combining an eye-piece with any objective, is arrived at directly by multiplying its number by the magnifying power of the objective, as given in the preceding list. An objective of 3·0 mm. focal length, for example, gives a magnification of 83·3 (at the conventional distance of 250 mm.); eye-piece 12, therefore, gives with this objective $12 \times 83{\cdot}3 = 1000$ for the same distance of vision.

In order to obtain the most favourable results, it is necessary that the eye-pieces used on Continental and English Microscopes respec-

tively, should be of different formulæ, because of the very different paths which the rays take in the two cases owing to the great difference in the lengths of the body-tubes. Both series are arranged to give precisely the same magnifying powers, the difference in the body-tubes being compensated for by the focal lengths.

The settings are so adjusted in both series, that the lower focal point of all the eye-pieces lies at the same plane when inserted in the body-tube. No alteration of adjustment is, therefore, required on changing the eye-piece, and the optical tube-length (i. e. the distance between the upper focal point of the objective, and the lower one of the eye-piece) which is the standard factor for the magnifying power, remains constant. This optical tube-length in the Continental Microscopes (excluding small differences between the various objectives) is equal to 180 mm., and in the English 270 mm., provided that the length of the body-tube from the upper surface of the setting of the objective, to the upper end of the tube on which the eye-pieces rest, is 160 and 250 mm. respectively.

Compensating Eye-pieces.

	Finder Eye-pieces.		Working Eye-pieces.				
Eye-piece Magnification	1	2	4	8	12	18	27
	For the Continental Tube.						
Equivalent Focal Length in mm.	180	90	45	22·5	15	10	—
	For the English Tube.						
Equivalent Focal Length in mm.	—	135	67	34	22·5	15	10

The eye-piece 1 is only made for the Continental Microscopes, and 27 only for the English, as the former would be too large for the English body-tubes, while the latter would have an inconveniently short focus with the Continental.

The eye-pieces of unusually low power, designated "Finders," serve the purpose of reducing to its lowest limits the available magnification with each objective, thus facilitating the preliminary examination of specimens, and avoiding the labour of searching for particular points with high powers. The Finder eye-piece 1 enables an objective to be employed with its own proper magnifying power, i. e. as if it were used as a magnifier without an eye-piece. In both the diameter of the field of view amounts to fully a fifth of the focal length of the objective used, with a relatively small angle—12° in 1, and 24° in 2. This is particularly favourable for rapid searches.

These Finder eye-pieces are of special service with water- and oil-immersion objectives, where great inconvenience is caused by having to change an objective already adjusted for another of longer focus.

The working eye-pieces for regular observation are likewise of

entirely new construction. They commence in both series with a magnifying power of 4, and are convenient to work with even in the highest numbers. The eye-point in all lies so high above the upper surface of the eye-lens, and the diameter of the lens is so large, that the usual inconveniences attending the use of eye-pieces of short focus are completely obviated.

The ordinary drawing prisms, and particularly the Abbe camera, may be used without difficulty on Nos. 4 to 18 inclusive.

All the eye-pieces are supplied in cylindrical mounts, the external diameter of which is 23·3 mm. for the Continental body, and 35·0 mm. for the English. Adapters to fit them to larger bodies can be made by any workman.

On each eye-piece is engraved the magnifying power, the focal length and tube-length for which it is adapted, as well as the name of the firm.

TABLE OF MAGNIFYING POWERS OF THE APOCHROMATIC OBJECTIVES, WITH THE COMPENSATING EYE-PIECES FOR A VISUAL DISTANCE OF 250 mm.

Focal Length of the Objective.	Finder Eye-piece.		Working Eye-piece.				
	1	2	4	8	12	18	27
24·0		21	42	83	125	187	281
16·0	15·5	31	62	125	187	281	—
12·0		42	83	167	250	375	562
8.0	31	62	125	250	375	562	—
6·0		83	167	333	500	750	1125
4·0	62	125	250	500	750	1125	—
3·0	83	167	333	667	1000	1500	—
2·5	100	200	400	800	1200	1800	—
2·0	125	250	500	1000	1500	2250	—

Projection Eye-pieces.—For such purposes as require the projection of a real image, but more particularly for overcoming the inconveniences which arise in photo-micrography when the objective alone is employed, as also in the use of the ordinary eye-piece or amplifier, a specially constructed projection series is supplied which externally resemble eye-pieces, and fit into the body-tube of the Microscope in the same manner.

They consist of a convex lens and a compound system, which like the apochromatic objectives, is most carefully corrected both spherically and chromatically, and is entirely free from any secondary chromatic aberration, and free from difference of focus between the visual and chemical rays. Between the convex lens and compound system, a diaphragm is introduced for limiting the field. The system can be made to approach or recede from the diaphragm.

When used to project an image on a screen for demonstration, or upon a photographic plate, the objective of the Microscope remains exactly in the same condition as when observing with an eye-piece. After a preliminary adjustment of the specimen by means of the ordinary eye-piece, the projection eye-piece is put in its place and its

projection-lens so adjusted that the edge of the diaphragm is focused as sharply as possible on the screen or ground glass of the photographic camera. This is accomplished by drawing out the projection lens more or less according as the distance between the screen or plate and the Microscope is reduced or increased. Finally, the image of the object is sharply focused on the screen or ground glass by the usual adjustments. The length of body for which the objective is adjusted for observation with an eye-piece, must always be exactly retained.

The cap of the projection eye-piece forms a diaphragm by which any false light from the body-tube is completely shut off. The size of the aperture of this diaphragm corresponds with the highest aperture of the apochromatics. When using either those of 0·6 or 0·3 it may occasionally be desirable to decrease the available aperture of the objective in order to obtain uniform sharpness of definition up to the margin of the field. For this purpose each projection eye-piece is supplied with two diaphragms of smaller apertures which fit in place of the normal one. It must not be forgotten to remove these from the eye-piece if the full aperture of the objective is to be effective.

Projection by this method gives extremely sharp, uniformly illuminated, pictures of any desired degree of magnification.

The projection eye-pieces are specially corrected for the apochromatics on the principle of the compensating series of eye-pieces, but may nevertheless be advantageously employed with ordinary achromatic objectives of large aperture. They are constructed for both Continental and English Microscopes, on somewhat different formulæ, according to the difference in tube-length. There are two numbers for each series, giving an

Eye-piece magnification of $\begin{cases} 2 \text{ and } 4 \text{ for the } 160 \text{ mm. body.} \\ 3 \text{ and } 6 \text{ for the } 250 \text{ mm. body.} \end{cases}$

These figures indicate, as in the compensating eye-pieces, the ratio in which, by means of the eye-piece and the given length of body-tube for which it is adjusted, the focal length of the whole Microscope is less than that of the objective alone (in so far as the eye-piece is adjusted to great distance).

For instance, the projection eye-piece 2 diminishes the focal length of each objective by exactly one-half; an objective of 3 mm. therefore will, with this eye-piece, project as large an image as an objective of 1·5 mm. without it, the screen or plate remaining at the same distance.

As the linear magnification of a projected image is the quotient obtained by dividing the distance of the image from the posterior focal point of the objective by the equivalent focal length of the latter, we can determine the magnification at any distance of the image from the eye-piece, by dividing this distance expressed in mm. by the focal length of the objective used, and multiplying the result by the number of the projection eye-piece employed. Thus the objective of 3 mm. gives with the projection eye-piece 2 an image magnified 1000 times at a distance of 150 cm., $\left(\frac{1500}{3} \times 2 = 1000\right)$. This rule holds good

for greater distances, but in the case of the smaller it gives too high a reading.

The diameter of the image on the screen or plate when the eye-pieces 2 and 3 are used is about 1/5 of the distance of the image, and with 4 and 6 about 1/3 of that distance.

The image distance may be reduced in the case of 2 and 3 to about 400 mm., and in 4 and 6 to about 250 mm., reckoning from the eye-piece. It can be increased to any desired amount.

For purposes of demonstration and for photo-micrography, where small pictures only are required, or in cases where the plate can be placed at a long distance, the projection eye-pieces of low magnifying power, such as 2 or 3, are to be preferred; for photographing with a short camera, however, the higher ones should be used.

It would be too much of an innovation to print the price list in full here, but we may mention that the prices of the objectives rise from 5*l.* for the dry 16 mm. to 20*l.* and 22*l.* 10*s.* for the homogeneous-immersion of 2·0 mm. and 3·0 mm. and 1·30 N.A., and 25*l.* and 27*l.* 10*s.* for those of 1·40 N.A. The eye-pieces vary from 1*l.* to 2*l.*

Prof. Abbe and Dr. O. Schott have also issued a pamphlet * descriptive of the new kinds of glass made at the glass manufactory at Jena, with full details as to their optical and other properties,† and a list of the various kinds, 44 in number, now supplied. The following are most of the novelties in the list:—

	Refr. Index for D.	Medium Dispersion.
Light Phosphate-Crown	1·5159	0·00737
Medium do.	1·5590	0·00835
Heavy Barium-Phosphate-Crown	1·5760	0·00884
Heaviest do.	1·5906	0 00922
Boro-silicate-Crown	1·5100	0·00797
Light Borate-Crown	1·5047	0·00840
Barium-silicate-Crown	1·5399	0·00909
Heavy do.	1·5726	0·00995
Heaviest do.	1·6040	0·01092
Boro-silicate-Flint	1·5676	0·01216
Borate-Flint	1·6086	0·01375
Heavy do.	1·6797	0·01787
Heaviest Silicate-Flint	1·9626	0·04882

Suggestions are made as to the glass best suited for various purposes, and on commencing the perusal of these passages we had the idea that we were coming to a description of the glass used for the new objectives. The following ingeniously worded paragraph, however, closes the subject:—

"In the case of Microscope objectives which require for the attainment of the highest capacity of performance not only agreement in the course of the dispersion of the crown and flint, but also the correction of the spherical aberration and its chromatic difference, it must be left to the skill of the practical optician to choose the most suitable means from the above series. The new objectives of Zeiss show what can be attained by their practical use."

* 'Glasschmelzerei für Optische und andere Wissenschaftliche Zwecke. Productions- und Preis-Verzeichniss,' 20 pp. and 1 pl., 8vo, Jena, 1886.

† See this Journal, *ante*, p. 316.

Observation of Opaque or Quasi-opaque Objects in the Microscope.—Dr. John Anthony writes us as follows:—

Given a Microscope, an objective, and a good "bull's-eye" side-light, the examination of opaque or quasi-opaque objects would seem to be a very simple affair, but experience teaches that much management is required to bring out all the points of structure in an object, or in making such object show at its best in any subsequent examination. It is therefore hoped that the following practical results of many years' work with the Microscope will be received by the Society in the spirit in which they are tendered.

A very large class of objects examined by aid of the Microscope are either opaque or semi-opaque. No one can doubt that if we are able to make out the structure of an object by merely looking *upon* its surface, the result is far more satisfactory than can be got by any process of seeing *through* it. But some objects which are semi-opaque, though the amount of transparency be but small, lend themselves to a combination of both methods, and the effect of this double lighting properly balanced is charming and instructive beyond expression. This may be instanced in the examination of the beautiful whole-insect preparations of Mr. Enock. The mere "bull's-eye" side-light would not reveal half the structure, and no one knows better than Mr. Enock himself the enormous gain by supplementing the light of the bull's-eye by a flood of transmitted light, illuminating in this case the body of the insect by means of the achromatic condenser, and balancing by careful manipulation the respective amounts of light; the effect, when properly got, is little less than magical, so much so, that even the advanced microscopist would not find his time wasted by practising this double-illumination on some rather intractable object.

In this double-lighting sometimes a better effect can be got by using the spot-lens instead of the achromatic condenser, in aid of the bull's-eye or silver side-reflector. In my hands the bull's-eye, which is really a French "crossed lens," of some 5 in. diameter, and so giving a flood of light, does not yield nearly so *pure* an image as a good parabolic reflector, which in its turn is somewhat troublesome to use.

Where there is a want of transparency in the object, then the use of the Lieberkühn comes in with advantage. This Lieberkühn was much in vogue in the early days of the Microscope, and its use is not to be despised for certain objects; it fell into disfavour from a tendency to illuminate an object equally all round, and to afford no contrast of light and shadow, no "boldness of image"; but this quasi defect is very readily obviated by blacking about one-third of the silver reflecting surface with Indian ink, which does no sort of damage, and so a preponderance of light on the one side can be got *of a very pure quality*, and with the advantage—a very great one, that with the finger and thumb grasping the tube of the Lieberkühn, the illumination can be made to revolve in azimuth, and so bring out salient points under every condition of light and shadow—a mode of verification which no searcher for truth would be disposed to neglect.

It has been assumed so far, that white light has been used, both

reflected and refracted, but observers have called attention to the effects got by mounting the objects on slips of "flashed" or "pot" glass, so as to show colours when the object is viewed transparently, and it is obvious that similar effects could be got by the coloured glasses used as screens; all may be useful, and there is certainly a charm in trying the various devices.

Before giving the very simple method, which in my hands produces by far the best effects, I would say that the habit of mounting objects in dark cells, either lined with wax or arranged with black paper pasted behind the slide, cannot be too much deprecated; if there can be a worse plan, it is putting an object intended to be looked at by reflected light into a cell built up upon white or opal flashed glass, as the glare of light from the polished surface is destructive of all comfort or precision in examination, and no manipulation on my part has been able to obviate the discomfort inseparable from this well-meant but mistaken arrangement.

When an object, then, is absolutely opaque, the following method would seem to fulfil all the conditions for its examination. Half a dozen pill-boxes are selected of a size to drop like caps on to the achromatic condenser, which is assumed to be always in position for use. On the outside flat part of these pasteboard caps are gummed rounds cut from various coloured French unglazed papers; these colours preferably shades of green, from emerald to olive, inasmuch as the chitin, which is so preponderant in all insect-preparations, is a shade of red, and the "complementary colour" of red is of course green. This law of "complementaries" or contrasts will be found to aid most agreeably in the display of an object, and to add much to its distinctness. The primary or secondary colours, or even neutral tints, may be used at will, as a colour-battery of this kind would not be costly, and it is evident that little or no trouble would be involved in the substitution of caps, without any disturbance of the side-light; or by racking the condenser armed with this colour-cap to form a tinted background of the desired shade or brightness, having the advantage of absolute freedom from glare, and forming a contrast to the local colour of the object under examination.

Sundry analogous devices have been tried, such as cards like object-slips, covered with coloured unglazed paper put behind the object at various distances; and they have this advantage, that they can be pitched at an angle and so give the effect of a graduated background, the defect being that they are rather apt to tumble out of the position in which they may have been placed. So the coloured cap to condenser has been preferred for continuous use.

Thus three methods are advocated for illuminating opaque or semi-opaque objects:—(1) For semi-opaque light, *on* by bull's-eye or silver side-reflector, and *through* by achromatic condenser or spot-lens when suitable. (2) For opaque objects uncovered, or mounted in transparent glass cells, the Lieberkühn partly blackened and revolved during use. (3) Colour-caps used on the condenser, and racked up and down; or coloured cards below the object, illuminated by bull's-eye or side-reflector.

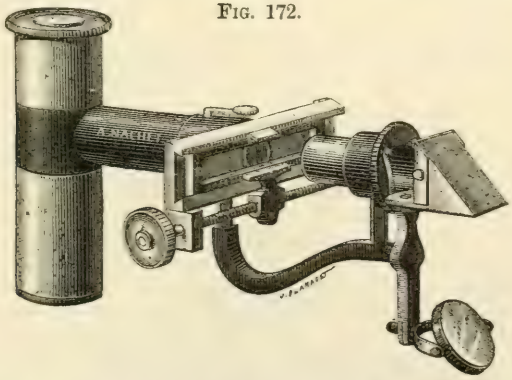
Examination of specimens by Coloured Light.*—Dr. M. Flesch recommends the insertion of a neutral tinted slide in the Abbe condenser when examining sections stained with red and blue dyes. As an example of the advantage may be cited the fact that some ganglion-cells stained with Merkel's indigo and carmine mixture have a special tendency to assume a blue colour, while others are stained red. This difference is found to be augmented by the use of artificial illumination and a neutral tinted slide.

Again, in making an examination of sections stained with eosin and hæmatoxylin, and where, owing to the thickness of the specimens the eosin stain could not be recognized, a successful result was obtained by using polarized light with a selenite plate, so placed that the field of vision showed up yellow. The large cells impregnated with eosin were thus seen to be of a red colour, while the blue nuclei had apparently disappeared.

Ahrens' Polarizing Prism.—Mr. Ahrens has recently added to his prism † a thin cover-glass at the end-face crossed by the line of section, thereby making this line almost imperceptible as well as affording protection against scratches. He has also found a new method of cutting the prism by which there is extremely little waste of spar.

Michel-Lévy's Comparator.—M. Michel-Lévy's Comparator (figs. 172 and 173) is based on the comparison of the colour of a crystal seen under the Microscope with that given by a wedge of quartz producing three orders of tints and which is taken as the unit of comparison.

Fig. 172.



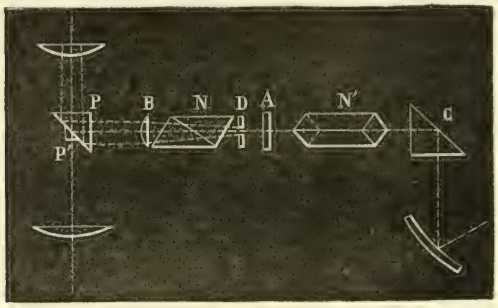
At NN′ fig. 173 are two Nicol prisms, between which slide the quartz A and a diaphragm D. The rays reflected from the small mirror are diverted at right angles by the prism C through the nicols, quartz and diaphragm, and made parallel by the lens B, being then reflected by the prism P through the eye-lens. To the hypothenuse

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 52. † See this Journal, *ante*, p. 397.

surface of P is attached a small prism P'. This allows the rays from the crystal on the stage to pass up to the eye which views them surrounded by the rays from the quartz, and a ready comparison is thus made.

By turning the milled head the quartz wedge can be moved in a horizontal direction, and a graduated scale enables the displacement to be measured in order to identify the tints.

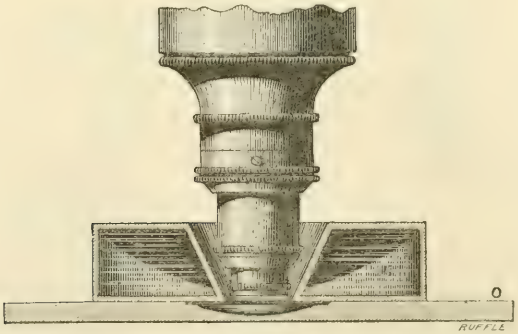
Fig. 173.



The light for the small mirror should be taken from the same source as that for the mirror of the Microscope, so as to avoid any error in the value of the tints. The apparatus is applied with best advantage to very small thin plates of minerals, not going beyond the tints of the first three Newtonian orders.

Israel's Warming Apparatus as a substitute for the Hot Stage.* —Dr. O. Israel's apparatus is so constructed that the illumination of

Fig. 174.



the objects is not interfered with, and the slide is warmed from above. It consists of a slide O (fig. 174), having a central hollow-ground well,

* Zeitsch. f. Wiss. Mikr., ii. (1885) pp. 459-63 (3 figs.).

round which is sunk a groove 0·1 mm. deep and 1 mm. broad, into which the cover-glass fits so that its upper surface is flush with that

Fig. 175.

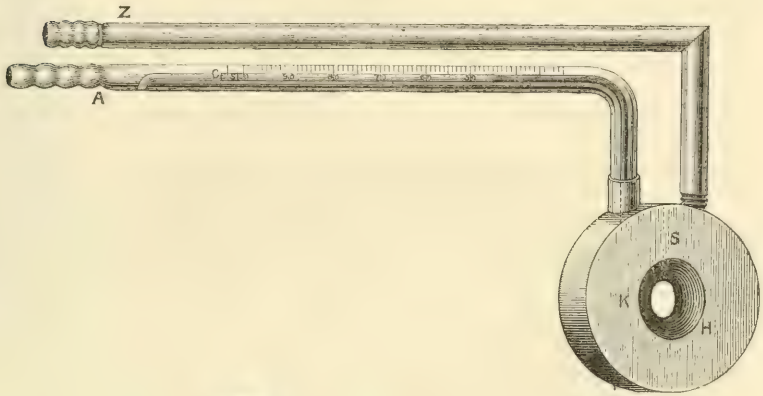
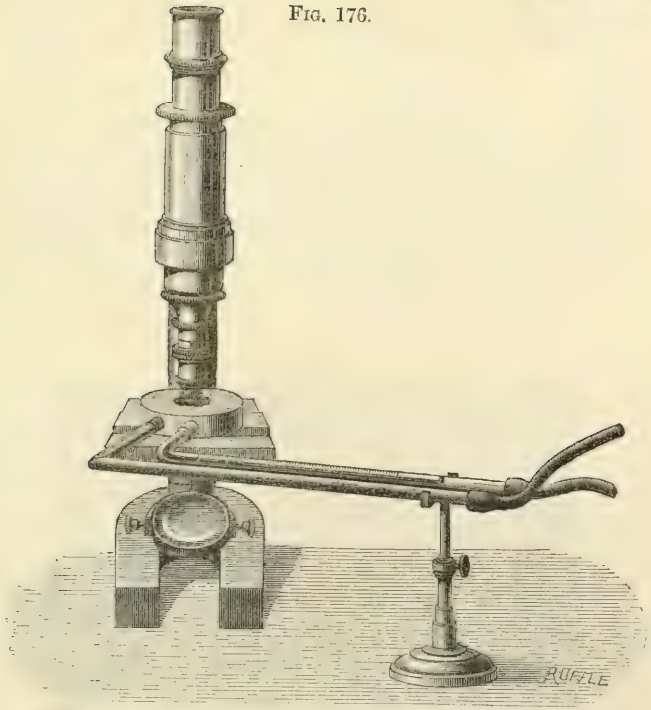


Fig. 176.



of the slide. Such a chamber is the more easily heated, since the glass itself acts as an insulator to the stage. The hot-water apparatus

consists of a flat, round metal box (figs. 174 and 175, H), with a central conical aperture. The entrance and exit pipes for the heated water (fig. 175, Z, A) are set on at a right angle to the side: the former, Z, is a metal tube; the latter, A, a glass one, is fitted with a thermometer, the bulb of which, K, passes into the box. A current is maintained by a partition S between the openings of the two pipes. These are supported by a stand (fig. 176), and their ends connected with rubber tubes.

Two precautions are necessary in using this apparatus. The first is to get rid of all air-bubbles in the water, and the second is to ascertain the temperature of the hot chamber. This is best done in the manner described by Koch.* The materials employed by Dr. Israel for ascertaining this latter point are a mixture of paraffin and vaselin, from which a substance with the desired melting point is easily prepared. Repeated trials with this apparatus show that if a temperature of 37° C. be required for the hot chamber, the temperature of the water in the capsule must range between 42° and 47° C. The apparatus can be adapted for direct heating after the manner of Max Schulze's stage if so desired.

Delage's Reversible Compressor.—Prof. Y. Delage has devised a form of compressor for the most delicate observations, figs. 177 and 178,

Fig. 177.

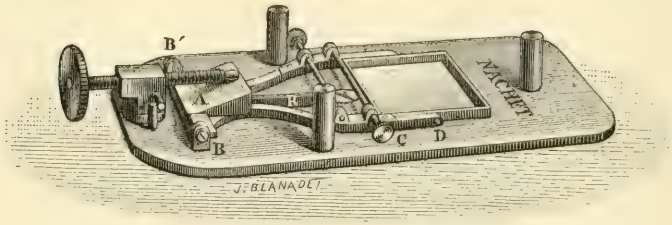
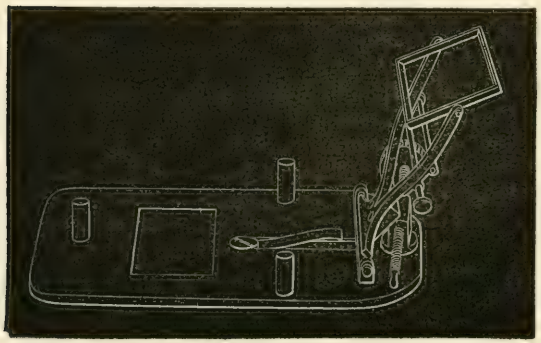


Fig. 178.



* Cohn's 'Beiträge zur Biologie der Pflanzen,' ii. p. 284.

in which the pressure is effected by the action of a screw on an inclined plane A, and working against the spring R. When the screw is turned on one side, the upper part of the compressor can be raised on the pivots BB' as shown in fig. 177. The frame holding the upper plate has a gimbal motion on the pivot D (and the corresponding one on the opposite side) and the frame can be detached by pressing the pin C and the corresponding one on the opposite side, causing the frame-holder to spring open slightly. The two glasses being oblong and lying crossed it is easy to add a drop of liquid during compression.

The compressor can be reversed, and in that case rests on the three small pillars which are high enough to allow the milled head of the screw to clear the stage.*

Coles' Self-adjusting Frog-plate.†—Mr. A. H. Coles' frog-plate is shown in fig. 179 (under side). It is 2 in. by 5 in., and it is claimed that "its adjustability, lightness, simplicity, the ease with which the

Fig. 179.

frog is secured without injurious pressure or loss of any blood, together with its cost, commend it to all users of the Microscope."

The binding cord is passed as usual over the plate and round the pins, and its free end is secured by simply drawing it under one of the small spring clips on the edge of the plate. The long springs are for holding the plate securely on any stage.

Micro-stroboscope for observing Muscle-contraction in Insects.‡ Prof. E. v. Fleischl employed in his experiments on muscle contraction in insects a "micro-stroboscope."

The poles of a small chromic acid battery were connected with the extremity of the exposed nerve proceeding from the insect wing, and the electric connection was made through the intermediation of small strips of tinfoil, insulation being effected by vaselin. This was carried out on the stage of a Microscope, and the observations were made under comparatively low powers. As the images of the tetanized muscle were imperfect and distorted, a "stroboscopic" disc of

* See Arch. de Zool., 1886.
† Micr. Bull. (Queen's) iii. (1886) p. 11 (1 fig.).
‡ Arch. f. Anat. u. Physiol., 1886 (Physiol. Abtheil.) pp. 67–71.

blackened cardboard was fitted closely over the eye-piece of the Microscope in such a way that the object was seen through the radial fissures, the images of the contraction and relaxation of the muscular fibrils being thus made perfectly clear and undistorted and easily observed.

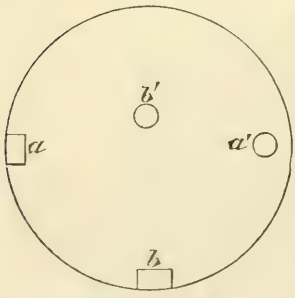
Determining the Thickness of Arterial Walls.*—Dr. H. Stahel uses the following method for ascertaining the thickness of arterial walls.

By means of a micrometer-screw having a thread of 0·5 mm., the milled head of which was divided to permit readings to 0·001 mm., a plate was moved up through the stage aperture, on which a square piece of artery, protected by a cover-glass, was placed. In order to avoid any chance error which might be caused by the unequal thickness of the cover-glass, the centre of the latter was always placed over the spot to be measured. The piece of artery and the cover-glass were accurately adjusted to the plate by the aid of slight pressure. The pieces should not be too large: as a rule, pieces the sides of which were 2 to 3 mm. were used. Vertically over the plate carrying the artery and cover-glass a needle was fastened by a band. The plate was then raised by the micrometer-screw until the needle-point touched the upper surface of the cover-glass. Accurate apposition was obtained by means of a hand-lens. The height was then read off on the micrometer-screw head. The height thus ascertained gave the thickness of the artery plus that of the cover-glass. The artery was then removed and the thickness of the cover-glass found in a similar manner, and the difference between the two gave the thickness of the arterial wall.

For the sake of accuracy frequent measurements were taken, and it was found in the result that the thickness of an artery's wall could be ascertained to within 0·01 mm.

Resolution of Diatoms whose Striæ are of unequal fineness.†—Mr. E. M. Nelson writes:—"Every diatom resolver with oblique light will have noticed the great difficulty there is (which in some cases amounts to an impossibility) to focus at the same time the longitudinal and transverse striæ of some of the Diatomaceæ. This will be found especially to be the case in diatoms whose striæ are of unequal fineness, such as *Navicula cuspidata* (36,000 and 65,000 per inch). Some observers have maintained that this appearance is the true structure, and that the coarse markings are on the exterior surface of the valve, while the fine are on the interior. To those who, like myself, hold that striæ are imperfectly resolved perforations, this theory is, of

Fig. 180.



* Arch. f. Anat. u. Physiol., 1886 (Anat. Abtheil.) pp. 45–63 (12 figs.).

† Engl. Mech., xliii. (1886) p. 328.

course, quite untenable. I wish to show how these differences of foci may be accounted for by the spherical aberration of the objective used.

Let fig. 180 represent the back of a 1/4 in. objective of 0·71 N.A., focused on a *Navicula cuspidata*, illuminated by two oblique beams, *a*, *b*, at right angles to each other; *a'* will represent the diffraction spectrum of the first order originated by the illuminating beam *a*, and the fine longitudinal striæ; and *b'* that by the beam *b* and the coarse transverse striæ.

It is evident that if the lens has not its spherical aberration properly balanced, the rays *a a'* passing through the outer zone of the objective will have a shorter focus than *b b'*. In other words, when the transverse striæ are in focus you will have to focus the lens further down before the longitudinal striæ appear. This is precisely what occurs in practice. The experiment is nothing more nor less than a refined kind of Abbe's test.

For my own part, I prefer to test an objective by flooding it with light from a large axial illuminating cone."

Actinic Contrast in Photo-micrography.*—Dr. G. A. Piersol considers that successful photo-micrography depends especially upon three conditions: (*a*) having all parts of the object accurately in the same plane; (*b*) having a well-marked differentiation between the elements of the tissues; and (*c*) having the object so stained and illuminated as to insure sufficient actinic contrast between it and the surrounding field or background.

The successful acquisition of the condition of actinic contrast, is not always readily had. While the blue stainings (hæmatoxylin, methyl-blue) are, of course, more actinically powerful than the reds and browns, yet so much depends upon the individual specimen in regard to opacity and thickness, that each case must be determined for itself. While a thick section stained in carmine will yield but a dark mass without detail, a similar section stained in hæmatoxylin may furnish a satisfactory picture. But the days of thick sections are past; the question now is, how shall we stain and illuminate the thinnest possible sections so as to yield good photographs?

While a very delicate section well stained with hæmatoxylin is all that can be desired for examination, we shall soon find that actinically it is far too transparent to produce a vigorous photograph, there being insufficient actinic contrast between the general blue colour of the field illuminated by the blue monochromatic light from the ammonia-sulphate of copper cell, and the bluish purple of the section. When the preparation of the specimen is under control, it will be found advantageous to prepare a few sections as already suggested,† by which the thinnest sections in the brown colours always markedly impress the plate.

In many cases, however, it is inexpedient to specially prepare objects for photography. For such cases a very valuable adjunct will

* Amer. Mon. Micr. Journ., vii. (1886) pp. 121–3.

† See this Journal, v. (1885) p. 559.

be found in the use of different coloured lights produced by tinted glasses, carefully adapted to the intensity and colour of the staining. The use of glass, or of solutions of a colour complementary to that of the object, has been long employed in the arts in reproducing paintings. Koch, in his 'Traumatic and Infective Diseases,' relates his experiences with this method, but condemns it as impracticable. On account of the length of exposure and vibration "the picture does not have sharpness of outline sufficient to enable it to be of use as a substitute for a drawing, or, indeed, even as evidence of what one sees." *

Notwithstanding the unfavourable experience of this skilled investigator, some subsequent results by this method have been most encouraging. Defrenne obtained excellent photographs of the *Bacillus tuberculosis* by means of fuchsin staining and green glass, and quite recently the author's own experience with this same bacterium and stain have been very gratifying. Since then a number of modifications have been tried. As a result of these experiments the practical deductions have been reached, that when the staining and thickness of the specimen are insufficient to give the necessary actinic contrast with the colour of the field, we can best succeed by employing a coloured glass, whose tint will be such as to give the contrast, as well as to afford light to sufficiently impress the plate where not occupied by the object. Such a colour will not be the complementary one in many instances. With blue stainings the use of the complementary yellow would yield but a faint image, since the weak actinic power of the transmitted rays are insufficient to deeply affect the unoccupied parts of the field. The substitution, however, of a suitable shade of green affords sufficient contrast of the object as well as permits the passage of rays sufficiently actinically powerful to adequately impress the surrounding parts of the plate.

With all these colours the exposure is greatly lengthened, with a medium green it being five to seven times longer than with blue light; as, however, the normal exposure is seldom over one second, the increase has practically little disadvantage. Not only for very minute objects, as bacteria, stained with methyl-blue, under high power, but equally for very thin hæmatoxylin or carmine sections under low amplification, has this green glass proved most useful. By its use it is always possible to obtain pictures, where all the merits of vigorous negatives with the beautifully sharp details alone obtainable from the thinnest sections are combined, and where the usual method yields but a weak image.

These suggestions apply especially to sunlight. To those engaged in such work, who have never employed these means, the shades of green offer themselves as valuable modifications of illumination well worthy of a trial. The exact time required—a matter of importance —must be determined for existing conditions by each manipulator.

Mr. J. W. Queen suggests † a trial of the stained gelatin plates now coming into use for the purpose of securing contrast. The

* Magnin and Sternberg's Bacteria, 2nd ed., 1884, p. 195.

† Micr. Bulletin (Queen's), iii. (1886) p. 32.

sensitiveness of these plates is much greater than usual, so that the time of exposure will be diminished instead of lengthened, and by using plates variously stained suitable contrasts might be obtained with differently stained specimens.

Mr. R. Hitchcock also refers * to the so-called ortho-chromatic or iso-chromatic sensitive plates now sold which "may be found useful in photo-micrography, but it is well to consider that they differ from other plates mainly in their greater sensitiveness to the less refrangible rays, while they are scarcely less sensitive to the blue which still preponderates. For this reason, in order to obtain strictly uniform results for all colours, coloured screens must be used, particularly when working with sunlight. The great advantage of such plates rests in the fact that they are sensitive to the red and less refrangible rays which do not at all, or only slightly, affect the ordinary plates."

ABBE, E., and SCHOTT, O.—**Glasschmelzerei für optische und andere wissenschaftliche Zwecke—Productions- und Preis-Verzeichniss.** (Glassworks for optical and other scientific purposes—Catalogue.) [*Supra*, p. 856.]
20 pp. and 1 pl. (8vo, Jena, 1886).

ALFEROW, S.—**Nouvel Appareil, servant à compter exactement les globules sanguins.** (New apparatus for exact counting of blood-corpuscles.)
[The enumeration method is more important than the moist chamber. Instead of counting by means of squares on the slide or in the ocular, a record of the blood-corpuscles is made on the ground glass plate of a photo-micrographic camera, which is fixed in the tube as far as possible from the objective. Fine adjustment is made with the stage. Instead of the preparation itself, a representation of it is thus used for the enumeration.]
Arch. Physiol. Norm. et Pathol., III. (1884) pp. 269–86 (3 figs.).

ANDRIEU, L.—**Sur un Chromatomètre, destiné à mésurer la couleur des liquides.** (On a Chromatometer for measuring the colour of liquids.) [*Post.*]
Comptes Rendus, CIII. (1886) pp. 281–4 (1 fig.).

BAUSCH, E.—**Illuminating Apparatus for the Microscope.**
[Description of the various forms.]
Bull. Rochester Acad. Sci., 1886, pp. 1–8.

BERGER, C. L.—**Hilfsapparate für die Bedürfnisse der Werkstatt. III. Apparat zur genauen Bestimmung der Brennweite von Objectivgläsern.** (Apparatus for the exact determination of the focal length of objectives [of the telescopes of geodetic and astronomical instruments]).
[Contains a description of a Microscope used for fixing spiders' threads, *post.*]
Zeitschr. f. Instrumentenk., VI. (1886) pp. 272–6 (3 figs.).

CZAPSKI, S.—**Die Mikrometerbewegung an den neueren Zeiss'schen Stativen.** (The fine-adjustment to the newer Zeiss stands.) [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 207–9 (1 fig.).

DENAEYER, A.—**Procédé phototypique industriel applicable à la reproduction des photomicrographies.** (Phototype process applicable to the reproduction of photo-micrographs.) [*Post.*] *Bull. Soc. Belg. Micr.*, XII. (1886) pp. 92–6.

English *v.* Foreign Microscopes.
[Inquiry by "Briton" (1) why English Microscope-makers should be unable to compete with the foreign makers? or (2) if they are able, why our schools of science should be so flooded with foreign instruments? Replies by S. Bottone that it arises from the "disparity in the prices of labour and food here and on the Continent"—by "Another Briton," suggesting

* Amer. Mon. Micr. Journ., vii. (1886) pp. 155–6.

a meeting at which "the whole of the opticians in London be invited to show the special forms of instruments they consider most useful to students"—by "Prismatique"—A. Caplatzi, that the foreigner can underbid us because he is better trained, more industrious, soberer, and more provident, &c., &c.—by "Prismatique" (2) that most of the foreign work is "make-believe," while our own is genuine—E. Holmes —A. K. C.—W. S. Franks—"Orderic Vital."]

Engl. Mech., XLIII. (1886) p. 580; XLIV. (1886) pp. 16, 39, 66, 88, 111.

FASOLDT, C.—**Resolution of 200,000 lines to the inch.**

["We have lately, with the use or aid of the second fine adjustment and internal illumination, resolved 200,000 lines per inch with homogeneous-immersion 1/16 in., and also with 1/12 in. homogeneous. Should you find or hear of an 'incredulous Thomas,' send him here. Only provided he has got first-class eyes, we will show him the 200,000. Furthermore, there is no reason for ridiculing, as not only one but a number have seen them, and would make affidavits accordingly if desired."]

Micr. Bulletin (*Queen's*), III. (1886) p. 32.

GILES, G. W. M.—**On Marine Collecting with the Surface-net.**

[Describes and figures a Botterill life-cell and aerating apparatus.—Also remarks on the handiest form of simple Microscope, and on examining and preparing the objects collected.]

Sci.-Gossip, 1886, pp. 79–80 (2 figs.).

GOWER, H. D.—**How to make a Tint-reflector.**

[Wooden pill-box and thin glass cover; or thin silvered glass, if the image is to be thrown down on a sheet of paper.]

Sci.-Gossip, 1886, p. 172 (4 figs.).

GROTH, P.—**Physikalische Krystallographie und Einleitung in die Krystallographische Kenntniss der wichtigeren Substanzen.** (Physical Crystallography and introduction to the crystallographic knowledge of the more important substances.)

[Part I. The physical properties of crystals. Part II. The geometrical properties of crystals. Part III. (pp. 543–674, figs. 565–621). The apparatus and methods for crystallographic-physical researches. A. Goniometer and refractometer. B. Polarization apparatus. C. Microscopes and microscopical measuring apparatus. (Includes Koch's Microscope for determining the elasticity coefficients, *post.*) D. Cutting and grinding apparatus.]

2nd ed., xv. and 710 pp., 631 figs. and 1 pl. (8vo, Leipzig, 1885).

Heurck's (H. van) Photographs of Amphipleura and Nobert's Bands.

[Includes note by Dr. Royston-Pigott that "they have in my opinion no equals."]

Amer. Mon. Micr. Journ., VII. (1886) p. 138.

„ „ **Method of taking Photo-micrographs.** [See *infra*, p. 900.]

Engl. Mech., XLIII. (1886) pp. 548–9, from *Brit. Journ. of Phot.*

HITCHCOCK, R.—**Photo-micrography. VII.**

[4. Developing *contd.*]

Amer. Mon. Micr. Journ., VII. (1886) pp. 131–3, 141–2.

JENNINGS, J. H.—**How to photograph Microscopic Objects.** A Manual for the practical Microscopist. (8vo, New York, 1886.)

KERBER, A.—**Ueber die Chromatische Korrektur von Doppelobjektiven.** (On the chromatic correction of double objectives.)

Central-Ztg. f. Opt. u. Mech., VII. (1886) pp. 157–8 (2 figs.).

"LENS."—**Black Illumination without Parabola.**

[The writer racked back and finally removed the parabola without losing the black ground!—the explanation being that, instead of placing the mirror in the axis, he had placed it excentrically.]

Engl. Mech., XLIII. (1886) pp. 509–10.

LEVI, J. N.—**Photo-micrographic Work and Apparatus.**

Bull. Rochester Acad. Sci., 1886, pp. 10–21.

MAYALL, J., Junr.—**The Microscope.** (Cantor Lectures.)
[I., II., III., IV., V. Origin of the Microscope. Modern Microscopes to the date of the application of achromatism. Achromatic Microscopes.]
Journ. Soc. Arts, XXXIV. (1886) pp. 987–97 (12 figs.); 1007–21 (19 figs.); 1031–48 (21 figs.); 1055–81 (25 figs.); 1095–1121 (26 figs.).

[MOORE, A. Y.]—**High *v.* Low Powers.**
[Note as to the relative capacities of a 1/6 in. of 1·35 N.A. and a 1/50 in. of 1·17 N.A., with editorial comments.]
The Microscope, VI. (1886) pp. 176–7.

NELSON, E. M.—**Some remarks on the interpretation of Microscopic Images with high powers.**
["I will now, if you will allow me, sum up the lessons taught by this resolution. They are five in number:—
1. There are no such things as markings on the Diatomaceæ. The so-called markings on the Diatomaceæ are the structure of the Diatomaceæ. One might, with equal propriety, call ribs markings on a skeleton.
2. The complete destruction of the hemispherule, bead, and pearl theory.
3. The contradiction of the statement 'that you cannot know anything about the structure of the Diatomaceæ, because all the diffraction spectra are not taken up.'
4. The great superiority of illumination by an axial cone to that by an oblique pencil.
5. The solution it affords to the questions—What is focus? What is adjustment?"]
Journ. Quekett Micr. Club, II. (1886) pp. 255–9, 283–4, and 286–7.

NORTON, C. E.—**Photo-micrography without a Camera.**
["In every respect it is equal or superior to the method with the camera, with the possible exception of photography of opaque objects."]
Amer. Mon. Micr. Journ., VII. (1886) pp. 152–3.

PIERSOL, G. A.—**Actinic Contrast in Photo-micrography.**
[Also remarks by J. W. Queen (*Micr. Bulletin*, III. (1886) p. 32) and R. Hitchcock (*Amer. Mon. Micr. Journ.*, VII. (1886) pp. 155–6). *Supra*, p. 865.]
Amer. Mon. Micr. Journ., VII. (1886) pp. 121–3.

POULSEN, V. A.—**Elektrik Lys** anvendt paa Microscopet samt en Beskrivelse af en af Instrumentmager L. Nyrop construeret Lampe.
[Small Edison lamp fixed beneath the stage and having a polished metal funnel reflector.] *Hosp. Tid.*, III. (1885) p. 81.

QUEEN, J. W.—**New Acme Lamp for Microscopic use.** [*Post.*]
Micr. Bull. (*Queen's*), III. (1886) p. 27 (1 fig.).

[QUEEN, J. W.]—**Prodigious Effulgence.**
["A series of leading articles by Dr. Royston-Pigott, entitled 'Microscopical Advances,' is running in the 'English Mechanic.' What great scientific value the editor has discovered in these nightmare-generating ecstasies we fail to conjecture."]
Micr. Bull. (*Queen's*), III. (1886) p. 27.
„ „ **Parfocal Eye-pieces.** [*Post.*] *Ibid.*, p. 31.

ROLLER, C.—**Die mikroskopische Untersuchung des Schweinefleisches auf Trichinen und Finnen.** (The microscopical examination of pork for trichinæ and measles.)
[Chaps. 3–6, pp. 12–7 on the Microscope.]
2nd ed., 34 pp. and 6 pls. (8vo, Trier, 1886).

SAHLI, H.—**Ueber einen automatischen Regulator für Brütöfen mit Petroleumheizung.** (On an automatic regulator for incubators with petroleum heating apparatus.) [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 165–73 (3 figs.).

SCHOTT, O.—See Abbe, E.

SHANKS, S. G.—**Measuring Blood-corpuscles.**
[Reply to Dr. Ewell's criticism, *ante*, p. 696.]
Amer. Mon. Micr. Journ., VII. (1886) pp. 138–9.

Stahel, H.—**Ueber die Beziehung der Wanddicke der. Arterien zum Blutdruck.** (On the relation of the thickness of arterial walls to the blood pressure.)
[Method of measuring, *supra*, p. 864.]
Arch. f. Anat. u. Physiol. (*Anat. Abtheil.*), 1886. pp. 45–63 (12 figs.).

Stein, S. T.—**Das Licht im Dienste wissenschaft icher Forschung.** Band II. Heft 4. Specieller Theil III.–V. Die Photographie im Dienste der Astronomie, Meteorologie und Physik. (Light in furtherance of scientific research. Vol. II. Part 4. Photography in astronomy, meteorology, and physics.)
2nd ed., viii. and 192 pp., 135 figs. and 1 phot. (8vo, Halle a. S., 1886).

Stowell, C. H. and L. R.—**Valedictory—Introductory.**
[Announcement of retirement from the editorship of the journal, and introduction of new editors. Also "salutatory" note of new editors.]
The Microscope, VI. (1886) pp. 172–4.

" " " **At last.**
[On the retirement of the editor of the Amer. Mon. Micr. Journ.]
The Microscope, VI. (1886) pp. 174–6.

Sydow, P.—**Anleitung zum Sammeln der Kryptogamen.** (Guide to the collection of Cryptogams.)
[Contains "The Microscope" pp. 6–19. Also measuring, drawing, mounting, and culture methods.]
iv. and 144 pp., 10 figs. (8vo, Stuttgart, 1885).

Vignal, W.—**Chambre chaude à régulateur direct pour le Microscope.** (Hot stage with direct regulator for the Microscope.) [*Post.*]
Arch. de Physiol. Norm. et Path., VI. (1885) pp. 1–10 (2 figs.).

Zeiss, C.—**Neue Mikroskop-Objective und Oculare** aus Special-Gläsern des Glastechnischen Laboratoriums (Schott & Gen.). (New Microscope objectives and eye-pieces of special kinds of glass from the glass manufactory of Schott and partners.) [*Supra*, p. 849.] 14 pp. (8vo, Jena, 1886).

β. Collecting, Mounting and Examining Objects, &c.*

Preventing the crumpling up of the Germinal Disc.†—Prof. G. Romiti has been endeavouring to find a means to prevent the crumpling up of the germinal disc of the hen's egg, which occurs during hardening in osmic acid or in osmio-chrom-acetic acid. Foster and Balfour had recommended for this purpose, to allow the germinal disc to get slightly dry on a glass plate and to place the embryo thus fixed on the glass plate in the hardening medium. Romiti substitutes a watchglass for the glass slide; the embryo is placed on the convex surface, and isolated in the blastoderm in salt water or in very dilute bichromate of potash.

New Method for demonstrating Karyokinetic Figures.‡—Prof. G. Bizzozero has devised a new method for demonstrating karyokinetic figures. For the iodine solution (Gram's method) is substituted a 1 per 1000 solution of chromic acid. The sections, made from material hardened in alcohol, are left for 5–10 m′ in the Ehrlich solution (gentian violet 1, alcohol 15, anilin oil 3, water 80), then, having been rapidly washed in absolute alcohol, are trans-

* This subdivision contains (1) Collecting Objects; (2) Preparing, (*a*) in general, (*b*) special objects; (3) Separate processes prior to making sections; (4) Cutting, including Imbedding and Microtomes; (5) Staining and Injecting; 6) Mounting, including preservative fluids, cells, slides, and cabinets; (7) Examining objects, including Testing; (8) Miscellaneous matters.

† Boll. Soc. Cult. Sci. Med. Siena, iii. (1885) (Sepr. Repr.) pp. 5–6.

‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 24–7.

ferred to the chromic acid solution for 30–40 m″. They are then returned to absolute alcohol for 30 or 40 m″, where their colour is somewhat diminished. In order to fix the colour better in the figures it is well to return the sections for 30 m″ to the chromic acid solution and then back again to absolute alcohol for 30–40 m″. This done, they are passed into oil of cloves, which extracts more colour. The author states that his experience is that oil of cloves exerts less influence on the nuclei in fission than those in repose. Consequently he uses oil of cloves as long as the colouring matter is extracted, in preference to alcohol which acts on both kinds of nuclei alike.

Better results are sometimes obtained by combining the effects of the two solutions. The procedure is then as follows:—5 to 10 m′ in the Ehrlich stain; wash for 5 m″ in absolute alcohol; 2 m′ in the iodine solution; 20 m″ in the chromic acid solution; 15 m″ in absolute alcohol; then 30 m″ in the chromic solution; 30 m″ in absolute alcohol; repeated washing in oil of cloves until the section is only faintly coloured; then dammar. The latter method is more suitable for examining nuclei of the liver, salivary glands, kidney, and pancreas; the former answers well with lymphoid tissue.

The preparations should be examined with an Abbe condenser without a diaphragm or with a very large one. In successful preparations the cell protoplasm is uncoloured, and in the nuclei in repose only the faintly stained nucleoli are to be seen, while the figures are a deep, almost brown, violet.

Preparations which have been hardened in chromic acid or in chrom-osmio-acetic acid stain well by this method if the sections are well washed in alcohol.

Reagents for studying the Structure of Gland-cells.*—1. Chromic acid.—Dr. J. H. List uses this as a 0·1 per cent. solution for eight days when needed for isolation hardening. When required for sections a 1/4 per cent. solution is used for three days; the specimens are then thoroughly washed, and having been hardened in alcohol to dehydration, are imbedded in celloidin. They are then stained with anilin, e. g. Weigert's Bismarck brown, rosanilin nitrate, and dilute Renaut's hæmatoxylin-glycerin. Sections made by this method show the structure of gland-cells (both goblet and mucous cells) excellently.

2. Müller's fluid.—This imparts the requisite hardness in a week or so; the specimens having been soaked for twenty-four to forty-eight hours, the isolated elements may be stained with methyl-green (1 per cent.), anilin-green (1 per cent.), or rosanilin nitrate. When sections are required, after the Müller's fluid the pieces are soaked and then hardened in alcohol, imbedded in celloidin, and then stained as before (No. 1).

3. Osmic acid.—This is used as a 0·5 or 1 per cent. solution. Small pieces of tissue are left in the 1 per cent. solution twelve to twenty-four hours; in 0·5 per cent. solution twenty-four to forty-

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 514–6.

eight hours. They are next thoroughly soaked for three or four days and the gland-cells isolated by teasing in distilled water or in glycerin and water (equal parts). Hæmatoxylin or Renaut's hæmatoxylin-glycerin are the best stains.

4. Flemming's mixture.—Pieces of tissue are left for not longer than twenty-four hours in the mixture and afterwards soaked for several days and then hardened up to dehydration in alcohol, imbedded in celloidin, and stained as before.

5. Alcohol.—70 to 90 per cent. alcohol may be used for pieces of limited size; the various structures are well preserved, and staining is almost always successful.

Preparing Striated Muscular Fibres.*—Dr. A. Rollett places small pieces of muscle just removed from the living animal in albumen of a fresh-laid hen's egg, and then cuts them in a freezing microtome (Jung's). A well-tempered knife is necessary. The still frozen section is placed on a slide, and can be examined at once with the albumen still adhering to it, or the latter may be replaced by a mixture of two parts glycerin and one part water. The sections are transparent and uncrumpled. Crumpling occurs when sections of frozen muscle are produced without the aid of albumen.

A similar procedure can be applied to the muscle of beetles which have lain only a short time in alcohol. The sections are put straight into glycerin. Muscles hardened for a longer time in alcohol are cut in celloidin. The objects are laid for twenty-four or forty-eight hours in a thin solution of celloidin, and then placed for twenty-four hours in a celloidin solution composed as follows:—Celloidin, 1 grm.; mixture of ether and alcohol in equal volumes, 4 c.cm.

The object immersed in this solution is then placed in a small covered vessel until the celloidin has, through slow evaporation of its solvents, assumed a jelly-like consistence. The mass is then cut all round and turned on to a glass plate, then reversed and put back in the glass vessel, some fresh solution is poured over, and the object sinks down in the midst. When taken out of the jelly-mass it is hardened in a mixture of 93 per cent. alcohol two parts and water one part, for twenty-four hours, staining with a weak solution of Renaut's hæmatoxylin, then alcohol, origanum oil, and dammar resin in xylol.

Isolating the Epidermis of Human and other Embryos from the Dermis.†—Dr. C. S. Minot describes a method for this purpose which is also convenient for the study of the development of hairs.

It is well known that if the fœtus dies and is retained, it is preserved for a considerable period without disintegration of the tissues in the amniotic fluid. In specimens thus preserved it is often found that the epidermis is loosened so much that strips can be removed without tearing off the underlying tissues. Now, as the amniotic fluid is little more than a salt solution, the facts just stated naturally suggest that a salt solution preserved from septic changes

* Denkschr. Math.-Naturw. Kl. K. Akad. Wiss. Wien, li. (1885) 48 pp. and 4 pls. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 92–3.

† Amer. Natural., xx. (1886) p. 575.

is sufficient to loosen the epidermis of the embryo. His experiments have satisfied the author that a sojourn of several days in a 0·6 per cent. solution of common salt, with 0·1 per cent. thymol added to prevent putrefaction, is a simple and satisfactory way of liberating the embryonic epidermis from its connections, so that pieces can be easily removed for histological examination, for which they are apparently still adapted; even the minute structure of the nucleus will persist through this treatment, though imperfectly.

Preparing Stratified Epithelia.*—Dr. G. Bizzozero proceeds to the examination of fresh epithelial scrapings from inside the cheek, by removing, first of all, other morphological elements in the following manner:—

Some saliva obtained by means of a pipette is transferred to three or four times its bulk of a 0·75 per cent. solution of common salt. The mixture is thoroughly stirred up and then allowed to stand. When the epithelial cells have sunk to the bottom, forming a white sediment there, the supernatant fluid is decanted off, and is replaced by a fresh quantity of salt solution. This procedure having been repeated three or four times the salt solution is replaced by dilute alcohol in which the epithelial cells may remain unimpaired for a length of time. In order to bring out quite clearly the linear striation, some iodide of potash solution is added.

Preparing Central Termination of Optic Nerves of Mammalia.† Sig. T. Bellonci hardens the part of the brain to be examined in osmic acid ($\frac{1}{2}$ to 1 per cent.) from 14 to 20 hours: then makes free-hand sections in 70 per cent. alcohol, and then immerses for three or four hours in 80 per cent. alcohol. After having been repeatedly washed the sections are placed in water under a cover-glass, and some ammonia is added. This makes the brain substance as transparent as glass, with the exception of the medullated fibres, which remaining black, stand out so clearly that it is easy to follow their course. Thickish sections allow the course of the fibres to be followed for a longer distance than thin ones.

Preparing the Brain.‡—Dr. J. Fischl would seem to have had less encouraging results from Weigert's hæmatoxylin stain than other observers. He found that ganglion cells gave the best results when hardened in alcohol. The most advantageous stains were alum carmine, borax carmine, hæmatoxylin, safranin, dahlia, and vesuvin. Flemming's fixative fluid is much praised. The author has tried Flesch's indigo carmine and borax carmine, but his results were not so satisfactory as those from the foregoing methods.

Examination of the Cerebral Cortex.§—Dr. Nissl states that isolation, without preceding maceration, may be carried out in any indifferent fluid (maceration having no special significance in the study

* Internat. Monatsschr. f. Anat. u. Histol., ii. (1885) pp. 278–83 (1 pl.).

† Arch. Ital. Biol., vi. (1885) p. 405.

‡ Prager Med. Wochensch., 1886, No. 2, and Wiener Med. Wochenschr. 1886, No. 5. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 100.

§ Ber. Naturforscher-Versammlung Strassburg, 1885, pp. 506 and 135.

of the nervous elements). When the fibres are the object in view, hardening should be effected in bichromate of potash, but if good images of nerve-cells be desired, alcohol should be employed. The latest modification of Weigert's hæmatoxylin should be used for staining nerve-fibres, but anilin colours are necessary for the cells. Magenta, dahlia, and vesuvin are especially suitable.

The procedure is as follows:—Harden and cut in 95 per cent. alcohol. Stain in a watery solution warmed to evaporation. Wash in 95 per cent. alcohol. Clear up in oil of cloves. Pass through benzin to Canada balsam. The author lays especial stress on controlling the results by simultaneous examination of the cortex of a normal brain.

Preparing the Iris of Man and Vertebrates.*—Dr. J. Koganeï removes the pigment epithelium, when not required for examination, by the aid of a fine camel's hair brush. The removal is facilitated by allowing the iris to remain in Müller's fluid for a longer time than usual. The pigment masses within the iris substance are decolorized by immersion in chlorine water for a few hours. When the pigment assumes a light brown tone, the specimen should be removed, as too long action of the chlorine water destroys the tissues. Peroxide of hydrogen gives no better results. The endothelium of the bird's iris can be demonstrated without the aid of the silver treatment, which is more especially suitable for the iris of white mice, rats, and rabbits. A fresh bulb is fastened down on its posterior pole, the cornea is snipped off, and a 0·25 per cent. silver solution is carefully dropped on the exposed iris by means of a pipette, until the silvering is sufficient. The iris is then cut out and inspected *in toto*. Any damage to the iris is thus avoided.

In order to show the posterior limiting membrane of the human iris devoid of nuclei and pigment, the author gives the following method:—The posterior iris pigment is brushed with a fine fairly stiff brush, until the pigment is to some extent removed from the radiating folds. The posterior surface is then carefully scraped with a scalpel, thus retaining the part of the boundary membrane which is made up of fine radiating fibres. These fibres swell and become pale in acetic acid, become brittle in 20 per cent. nitric acid, but remain firm and separate from one another easily in 30 per cent. caustic potash. The fibres are unaffected in trypsin solution. The limiting membrane takes up colouring matter with difficulty. Eosin answers best. Carmine and hæmatoxylin not well. Picric acid and palladium chloride stain it and the connective tissue yellow.

Preparing the Retina.†—Dr. W. Krause describes a variety of methods for preserving, hardening, staining, and imbedding the retina.

A 10 per cent. solution of chloral hydrate is very suitable for preserving purposes. From teased-out preparations of the retina

* Arch. f. Mikr. Anat., xxv. (1885) pp. 1–48 (1 pl.).

† Internat. Monatsschr. f. Anat. u. Histol., i. (1884) p. 225. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 396–7.

thus treated are obtained excellent images of the finer parts of the retina, especially from the layers of the rods and cones.

The author recommends hardening and staining the retina *in situ*, i. e. while still associated with the sclerotic and choroid, with a 0·3 to 1 per cent. hyperosmic acid or 0·2 per cent. chromic acid solution. For the latter he uses alum carmine and picrocarmine. Very fine staining was obtained by means of iron and vanadium chloride in combination with 2 per cent. tannic or gallic acids. By these reagents the rods and cones, the internal granular layer, and the nuclei of the ganglion cells took on a deep blue to a black colour; while the rest of the constituents of the retina remain unstained. They bore after-staining with anilins, especially acid fuchsin, well.

In cutting the retina, the chief difficulty is to obtain sections which have a perfectly flat surface throughout, and which on their whole extent show the same retinal layers. The cause of this difficulty lies in the spheroidal form of the retina itself, and secondly, in the faulty placing of the preparation in the microtome. Krause tried to do away with this inconvenience by imbedding pieces of the retina in the object-carrier itself, by means of paraffin, a piece of cork, and some tin-foil. A disc of paraffin, to which the proper consistence had been given by mixing some vaseline with it, was fixed to the cork, and this latter fastened on the carrier. The tin-foil was apparently used merely for the purpose of keeping the retina straight. By this means Krause obtained perfectly flat sections.

Preparation of the Eye for Histological Examination.*—Mr. J. W. Barrett thinks that sections of the entire eye can only be prepared with the aid of imbedding and infiltrating materials; if celloidin is to be used the eye should be opened by a short incision through the sclerotic, and should be placed in Müller's fluid and chromic acid solution, or better 2½ per cent. watery solution of carbolic acid if a section of the lens is desired. After alcohol of various strengths it should be stained with alcoholic borax carmine (formula: carmine, (No. 40) gr. xv.; borax, 1 dram; water to 8 oz.; dissolve by warming, and slowly evaporate to 4 oz. Add 7 oz. of alcohol). After washing it should be transferred to alcohol and then to an equal mixture of alcohol and ether. After twenty-four hours it should be transferred to a thin solution of celloidin in equal parts of alcohol and ether. In two or three days the celloidin will have penetrated, and the eye may be now imbedded.

This should be done in a box with a perfectly flat floor, and the eye covered with a tolerably thick solution of celloidin. Put under a bell-jar, the alcohol and ether will diffuse and the celloidin slowly consolidate; the bell-jar must be lifted from time to time. The time necessarily varies from one to six days. If the whole mass is too large for sections, it may be cut into slices about a quarter of an inch thick. Directions for cutting are added. Sections of parts of the eye, without the lens, of young or of embryonic eyes may be readily obtained by infiltrating and imbedding in paraffin by the chloroform process.

* Quart. Journ. Micr. Sci., xxvi. (1886) pp. 607–21.

The best sections of the retina were prepared by fixing and hardening in the watery solution of osmic and chromic acid (1/4 per cent. chromic acid, 1/10 per cent. osmic acid) in which they were placed for from 24–48 hours, and then put into alcohol and carbolic acid for 14 days more; the retina was then stained in bulk, Kleinenberg's solution being the best when thin sections are required; and finally, infiltrated and imbedded in cacao butter; this gives the thinnest and best sections with a minimum amount of trouble. A piece of the eye must be dehydrated in alcohol, cleared in oil of cloves, and placed in the butter melted at 35° C. for from four to six or even twelve hours; it should then be imbedded in the butter in the usual way. When the butter is quite hard the sclerotic and part of the choroid should be detached with a sharp scalpel, so that the retina and part of the choroid alone remain to be cut into sections. The mass cut away should be replaced by a little melted butter.

Substitute for Bone-grinding.*—Prof. W. Flemming uses bones which have become perfectly decalcified by the prolonged action of chromic acid, hydrochloric acid, and spirit. From this material sections 10 to 25 μ thick are made under spirit, and then steeped in water. After having been dried on blotting-paper, they are spread out on a glass plate, and then covered with another. The glass plates with inclosed sections having been placed in a dish are covered up with spirit. In about half an hour the sections have become sufficiently flat to allow of their removal to absolute alcohol. When thoroughly dehydrated, they are spread out flat on a glass plate and covered with a layer of blotting-paper, over which is laid another glass plate. In this position they lie for at least a day, until they are dry. The drying may be hastened by slight heat.

In order to mount the sections warm balsam must be employed. A drop of melted balsam is placed both on the slide and cover-glass, the section is spread out carefully in the balsam on the slide, and the cover-glass then imposed. A stiff clip must be put on at once.

The defect of this method is the large areas of tissue which sometimes fail to show the canals and canaliculi; a defect caused probably by their walls having become agglutinated during decalcification and having failed to separate when drying. But with this exception, the process may be recommended as an efficient substitute for the slow and tedious process of grinding bones down for microscopical preparations, the canals and canaliculi in the dried and decalcified sections giving as good results as those obtained by the more tedious and difficult method.

Preparing Mid-gut Gland (Liver) of Mollusca.†—Dr. J. Frenzel's examination of the gland tissue was made in dilute sea-water or in salt solution of not less than one per cent. Hardening, especially of sea molluscs, did not succeed perfectly (sublimate in aq. dest., sea-water, or weak spirit act best; osmic acid is useless as it does not

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 47–9.

† Arch. f. Mikr. Anat., xxv. (1885) pp. 48–84 (1 pl.). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 85–6. See this Journal, v. (1885) p. 792.

penetrate). The sections having been stained are stuck on with chrome-gum, which is made as follows:—Gum arabic dissolved in water to a thin mucilage, chrome-alum dissolved in water, added in excess to the former; glycerin a considerable quantity; of spirit a small quantity, to render the gum more easily spread on glass. A thin layer of the adhesive is spread on the slide with a brush or with the finger. The paraffin preparations are then laid on and allowed to dry at a temperature of 30°–45° C. Then turpentine, alcohol, or staining with an alcoholic or watery fluid, washing, alcohol, &c.; balsam.

Karyokinesis in Arthropods.*—In the study of karyokinesis in the Arthropods, Prof. J. B. Carnoy obtained the best results with the two following mixtures:—

(1) (Modified form of Flemming's mixture). Chromic acid (2 per cent. or more), 45 parts; osmic acid (2 per cent.), 16 parts; glacial acetic acid, 3 parts. (2) Corrosive sublimate; glacial acetic acid (1 per cent.). The object (testes) is left from one to ten minutes in one of these mixtures; then washed in distilled waters and further hardened in alcohol.

Preparing the Mid-gut of Insecta.†—According to Dr. J. Frenzel chromic acid is not suitable for the examination of the intestine of Arthropoda. A mixture of nitric acid and an alcoholic sublimate solution gave satisfactory results. The strength of the alcohol and the amount of sublimate in solution does not appear to matter. The author used 80 per cent. alcohol with sublimate half saturated. No particular caution is necessary as to the amount of acid; a drop too much or too little doing no damage. To the above solution a drop of concentrated sulphuric acid is added to every one or two cubic centimetres. The presence of this acid induces a quicker penetration of the preservative fluid into the tissues and hinders the formation of insoluble mercurial compounds. The more acid the solution and the smaller the piece of tissue the shorter the time it is left in the fluid. For pieces about the size of a pea five to ten minutes are quite sufficient. After hardening in sublimate, alcohol is advantageous. The tissue is washed and left in 90 per cent. alcohol.

Methods of Studying the Nervous System of Annelids.‡—Maceration is the best means of demonstrating the existence of a peripheral nervous system (*Polygordius*, *Protodrilus*, and *Saccocirrus*), and of showing its relation with the central nervous system. As macerating agents, M. J. Fraipont employed weak alcohol (36–48 hours), chromic acid (1/100 per cent., 24 hours), and a weak solution of bichromate of potash (48 hours).

After treatment with one of these agents, a definite portion of the

* "La Cytodiérèse chez les Arthropodes," p. 211 (Extrait de la Revue 'La Cellule,' i., 1885). Cf. Amer. Natural., xx. (1886) p. 578.

† Arch. f. Mikr. Anat., xxv. (1885) pp. 229–306 (3 pls.). See this Journal, *ante*, p. 231.

‡ Arch. de Biol., v. (1884) pp. 251–4. Cf. Whitman's 'Methods in Microscopical Anatomy and Embryology,' 1885, pp. 198–9.

annelid may be placed on a slide, teased apart under the dissecting Microscope with fine needles, and then examined in a drop of the macerating fluid; or it may be freed from its cuticula, and subjected to gradual pressure under a cover-glass. This treatment causes the preparation to flatten out, but does not dissociate the tissues so far as to obscure the relations existing between the different layers and their constituent elements.

In some cases good results may be reached by giving light taps on the cover-glass with the point of a needle for ten minutes or more. In either case the progress of dissociation can be followed with the Microscope.

Specimens to be sectioned with the microtome should be so killed that they remain straight and extended. They may be killed by adding very slowly alcohol to the water. As soon as they cease to move they should be taken out and extended on a slide, and then hardened with alcohol, osmic acid, picro-sulphuric acid, chromic acid, or corrosive sublimate.

Another method of killing is to pour hot corrosive sublimate over the worm after it has been stretched out on a dry slide. A mixture of osmic acid (1 per cent.) and chromic acid (1/5 per cent.) in equal parts was also employed with some success.

For colouring, borax carmine was used after sublimate and chromic acid; picrocarminate of ammonia after alcohol, osmic and picric acids; hæmatoxylin and anilin dyes after chromic acid.

Preparing the Nervous System of Myzostoma.*—Dr. F. v. Wagner preserves the material for examination partly in picrosulphuric acid and partly in Lang's fluid. A hot saturated solution of sublimate was found to be the best fixative. Picrocarmine was principally employed as a staining agent. To obtain distinct staining of the nuclei of the abdominal ganglia the animals were left in picrocarmine five to seven days; in alum carmine ten to twelve days. When picrocarmine is used the superfluous staining matter and acid should be removed by long immersion in weak spirit. The sections, which were from 0·01 to 0·015 mm. thick, were fixed by Giesbrecht's method. In order to bring the outline of the nervous system and the nerve-trunks into view, moderate crushing under the cover-glass is employed.

Natural Preservation of Rotifera and Pond Organisms.†—Mr. E. B. L. Brayley, by the following formula (which he thinks is original), has been enabled to mount, amongst others, *Melicerta*, *Œcistes*, *Stephanoceros*, *Asplanchna*, *Synchæta*, *Eosphora*, *Scaridium*, &c., the tube-dwellers all fully extended from their tubes, and the others with cilia exserted in a natural manner. In the transparent forms the internal structure can be easily studied.

Chromic acid, 2 gr.; saturated aqueous solution of salicylic acid, 1/4 oz.; distilled water, 1 oz. Add about two drops of the above to each

* F. S. Leuckart, 52 pp., Graz, 1886 (1 pl.). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 84.

† Sci.-Gossip, 1886, pp. 149–50.

teaspoonful of the water containing the rotifers. Its action should be very slow, taking six or more hours to kill, the animal swimming about as usual for some time. If too much be used the rotifer at once doubles up, swells, and is useless. The water should hardly be perceptibly tinted. Mount in the same water in which the creature is killed. It is preservative as well as fixative. With muddy water, transfer the rotifers to clean before adding solution. With Floscules it is advisable to fix in the same cell they are intended to be finally mounted in, as moving disarranges the setæ. To study internal structure, first starve the rotifer for a few hours in clean water. There are two points which make failure possible. First, the exact quantity to use—this can be acquired by practice alone; use as little as possible. Second, in certain waters a thick deposit is thrown down some hours after the solution is added. The only way to obviate this is to transfer the rotifers to fresh water and try again. Some mounts of *Asplanchna priodonta* are as perfect now as when put up two years since. Seal with Ward's brown cement: this had better be used with all the organisms; it is very reliable and easy to work.

The following formulæ are also given for Infusoria and other organisms:—

For *Carchesium* and other Vorticellina use a saturated solution of picric acid. Apply suddenly when the zooids are extended: well wash in alcohol. To stain prepare as follows: alcohol, 75 per cent., 2 oz.; hydrochloric acid, 4 drops; carmine, 3 grains. Boil this preparation slowly for 10 minutes; when cold, filter. If the stain shows a tendency to yellowness add one or two drops of ammonia, until the right colour is restored, and filter again. After staining wash out the excessive stain in acidulated alcohol, then transfer through absolute alcohol and cloves to balsam. The transference into the cloves must be carefully done, or great shrinking will take place. Introduce a few drops of oil of cloves into the bottom of a precipitating glass containing the alcohol, and let the stained Infusoria gravitate into the cloves, then withdraw the alcohol, add a little more cloves, and transfer into balsam. Picric acid will not satisfactorily kill *Paramecium*, *Urostyla*, &c.

Salicylic vinegar (pyroligneous acid, 100 parts; salicylic acid, 1 part) will be found the most generally useful. It kills such forms as *Paramecium*, *Coleps*, *Spirostomum*, *Stentor*, &c., and certain *Vorticellæ* fully extended, and can be used as a mounting medium.

A saturated solution of bichloride of mercury is very useful for fixing *Paramecium*, *Urostyla*, &c., but generally causes *Vorticellæ* to contract. Great care must be taken to wash away every trace before mounting.

The efficacy of all the foregoing solutions largely depends on the particular medium used being applied suddenly and in a concentrated form; that is, have as little water surrounding the Infusoria as possible.

Osmic acid is very useful at times, applied as a vapour. Put the drop of water with the Infusoria on the cover-glass, and hold it over the mouth of a bottle containing osmic solution. A drop applied to

water containing any Tentaculifera fixes them most satisfactorily. Care must be taken not to use too much, or they will become blackened and useless.

Entomostraca and small larvæ can be fixed with bichloride of mercury, and after being thoroughly washed, mounted in Noll's medium. Salicylic vinegar (as above), 1 vol.; dilute glycerin (glycerin, 1 vol.; water, 4 vols.), 10 vols.; Farrant's medium, 11 vols. This is generally a most useful fluid to keep by one, but does not answer where the integument of the object is very chitinous. Vermes are fixed admirably either by picric acid solution, or bichloride of mercury, and *Hydræ*, by bichloride of mercury solution. *Hydrachnæ* may be splendidly preserved by putting them living into a cell containing a saturated solution of boro-glyceride, and sealing the mount down. The animal will probably live in this for a day or two, and then will be perfectly preserved in form and colour; while for Algæ, a few drops of saturated aqueous solution of salicylic acid added to the water will preserve *Volvox*, showing cilia, and *Spirogyra*, without contracting chlorophyll spirals, &c. Use very little of the solution, otherwise it will bleach.

Preserving Preparations of Algæ.*—Dr. W. Migula, after alluding to the difficulty of preserving good preparations of algæ, e. g. Desmidiaceæ, on account of the plasma crumpling under the influence of glycerin and acetate of potash, and also because the more complex fluids destroy the chlorophyll, states that the contraction of the protoplasm may be perfectly prevented, if, so long as the algæ are in pure water, a drop of 1 per cent. osmic acid be placed on the edge of the cover-glass. By this means the plasma is fixed without tissue change, and after about 10 or 20 minutes the acetate of potash may be added. Desmidiaceæ retain their form and the structure of the plasma excellently.

Removal of Siliceous Coverings from Fossil Diatoms.†—Dr. O. N. Witt gives, by way of introduction, an account of the preparation of material for microscopical research, which forms an important contribution to the preparation-technique of fossil diatoms.

Dilute hydrochloric acid is poured over bean-sized pieces of the raw material, which is then heated in a water-bath. As there is but little chalk or iron in solution, the adhesion of the particles is much diminished, a condition favourable to further procedure. The acid is then poured off and the residue washed with distilled water. It is next heated with a 20 per cent. solution of carbonate of soda, in which it is boiled for six or eight hours. The result is a fine soft powder, which is again washed by decantation with distilled water. The powder is then treated with strong hydrochloric acid whereby fresh quantities of chalk and iron are dissolved. The author then treated the material (after first washing out the hydrochloric acid) with fuming nitric acid, to which had been added some chromate of

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 47.

† Sapiski Russischen Mineral. Gesell., xxii. (1885). Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 573-5.

potash. By this means the greatest part of the organic substances contained in the marl was destroyed.

Then follows a treatment, the object of which is the decomposition of the sulphur present. This consists in acting on it with concentrated sulphuric acid. If the operation is to succeed well, certain precautionary measures have to be observed. After the treatment with nitric acid, washing must be carefully performed, and the whole residue collected in a small paper filter; when this fluid is quite dropped away it is further dried in a folded filter-paper in such a way that no pressure is exerted on it. The filter is then opened, and with a platinum spatula the whole mass is put into very concentrated sulphuric acid which has been previously placed in a hemispherical porcelain or platinum dish. The dish is covered with a watch-glass, and the sulphuric acid made to boil. As a rule this (acid) gets stained black from the presence of organic substances, paper-fibres, and the like. Saltpetre is then added until the mixture becomes white. The sulphuric acid is boiled for at least one hour. By this means the whole of the sulphur is completely decomposed. When the vessel is cooled down, its contents are poured into distilled water. All the siliceous matter sinks to the bottom in two or three hours, and can be perfectly washed by decantation.

The fine snow-white shining precipitate thus obtained is now examined microscopically. If it still contains sulphur or its insoluble decomposition-products, recognized by their form and their opacity, these must be removed by careful treatment with dilute solution of soda. This last step is scarcely necessary in well-conducted operations, and the last steps of the procedure can be entered on. The whole mass must be allowed to settle in a glass jar, and the supernatant water poured off as completely as possible. The strongest ammonia is then poured over the precipitate, stirred up, covered with a watch-glass, and allowed to stand for twenty-four hours. The glass is then filled up with distilled water and the precipitate washed several times at intervals of two hours. The first water is slightly clouded (like milk), from the presence of finely divided amorphous silicic acid, which only settles after standing for twenty-four hours. The washings are to be continued until the supernatant water is perfectly clear and bright. The residue in the glass consists of pure siliceous organisms, which are preserved for use in well-closed flasks under alcohol.

By this ammonia treatment the very small particles of amorphous silicic acid acquire a motion, by the aid of which they are kept buoyed up, as it were, in the fluid, while the far larger siliceous organisms sink down between these to the bottom of the vessel.

Cultivating Schizomycetes.*—In his investigations on putrefaction Bacteria and their relation to septicæmia, Dr. G. Hauser employed Koch's method, to which, as it is so well known, we need not further allude. His procedure for breeding the Schizomycetes,

* Hauser, J., 'Ueber Fäulnissbacterien und deren Beziehung zur Septicämie. Ein Beitrag zur Morphologie der Spaltpilze,' 15 pls., 8vo, Leipzig, 1885. Cf. Zeitschr. f. Wiss Mikr., ii. (1885) pp. 554–5.

isolated from putrefactive foci, in pure hydrogen or in carbonic acid gas, is, however, original.

Two ordinary test-tubes, one 20 cm. long, of strong but easily fusible glass, and provided with a secondary tube drawn off to a point, the other about two-thirds the length, are united about their lower third by a small glass tube. The larger tube is closed by a cotton-wool plug, while the smaller is filled almost to the mouth with cotton wool. After the apparatus is sterilized by heating to 170° C., the larger test-tube is drawn out, pretty thin, at its upper third, and its lower fourth filled with Koch's gelatin. After waiting several days to see if it remain unclouded, it is inoculated with the fungi to be examined, and the upper end melted off where it was drawn out. The side tube and the connecting pipe are then drawn out fine, the latter about the middle. The smaller test-tube is fitted with a caoutchouc plug perforated by a glass tube in connection by a rubber pipe with the gas apparatus. As soon as the fore part of the side-tube is broken off the gas rushes in, filtering through the cotton-wool plug in the smaller test-tube, whereby all impurities, especially Bacteria, are prevented from entering.

A quarter of an hour suffices to drive all the air from out both tubes and to replace it with the desired gas. While the stream is in full flow, the points of the side- and the connecting-tubes are melted off. In this way any gas can be supplied to a gelatin cultivation without possibility of escape.

New Hardening Mixture.* — Dr. J. B. List has suggested a hardening mixture which, he says, gives pre-eminently satisfactory results with delicate and complex tissues. It consists of a half saturated watery solution of sublimate, to every 1 ccm. of which solution is added one drop of picrosulphuric acid. Histological relations are not only well preserved, but delicate easily lacerable organs acquire a consistence which enables them to withstand teasing out with needles.

The author's method is merely to put two or three drops of the solution by means of a pipette on the exposed organs, and allow it to work for two or three minutes. He then washes with distilled water, and mounts in glycerin. After-staining was found to be very easy, picrocarmine being usually adopted. By this method the author succeeded in demonstrating the intestinal canal, nervous system, &c., of Coccida.

Stein's Simple Imbedding Apparatus.†—Prof. S. v. Stein recommends instead of the clamp arrangement on the microtome, a metal box open above, and consisting of two tubes of tin. The undermost tube, provided with a bottom, is 10 mm. high ; the upper one, 30 mm. high, is pushed over it. From the floor of the box project three screws, 4 mm. high, for the better adhesion of the imbedding mass. When used the upper tube is oiled, the imbedding mass poured in until the screws are covered, the specimens adjusted and then the metal tube

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 43–4.
† Centralbl. Med. Wiss., 1884, p. 100.

is filled up with imbedding mass (1 part oil, 2 parts wax). When quite cooled down the upper tube is removed. Cutting is best done under water.

The advantages claimed for this method, which is especially recommended for preparations of the nervous system, are (1) the object is not subjected to any pressure; (2) the knife keeps sharp for a long time.

Imbedding Pharmaceutical Preparations.*—Dr. E. Vinassa imbeds pharmaceutical preparations in a mixture of glycerin and gelatin under the vacuum pump. This pump is of copper of 5 litres capacity, heated by steam and connected with a Körting's pump. The floor of the vacuum pump is covered with a layer an inch thick of paraffin (melting point 56°); during the whole time it is in use it is kept at a temperature of 58°–60° C. In the bath are placed five tall and widish boxes, which are for imbedding masses of different consistencies. The formula for the imbedding mass is, Gelatina alba, 15 grm.; aqua; glycerinum, āā, 100 grm. After the bath has been warmed for some time the pressure is regulated so as not to exceed 200 mm. The air in the cell-spaces is thus slowly driven out and the mass begins to froth. After the lapse of some hours the air is so far removed from the object that the stopcock of the air-pump may be gradually opened until the manometer indicates about 720 mm. By this measure the water is driven off, and in a few hours the gelatin assumes the consistency of a stiff jelly.

For hygroscopic or very mucilaginous roots, or such as have large air-passages, the quantity of water in the imbedding mass must be reduced one-half. Very fibrous tissues require to be left longer than usual in the air-pump.

Very dense woods such as *Lignum juniperi* and *Taxi* require to be left *in vacuo* for four hours in a mixture of equal parts water and glycerin, so that all the air is replaced by glycerin. This done they are removed to a warm vacuum for eight to fourteen days until frothing no longer occurs. When this has been repeated two or three times, they will be found quite ready for cutting. Woods rich in resin or pigment must be first macerated in alcohol. The *Rhizoma Caricis*, *Arnicæ*, *Graminis*, *Stipites Dulcamaræ*, &c., after having been saturated with gelatin, must be fixed in elder pith for cutting.

The author has tried paraffin and its mixtures, and also oils mixed with tallow or wax, but has always failed to obtain satisfactory results.

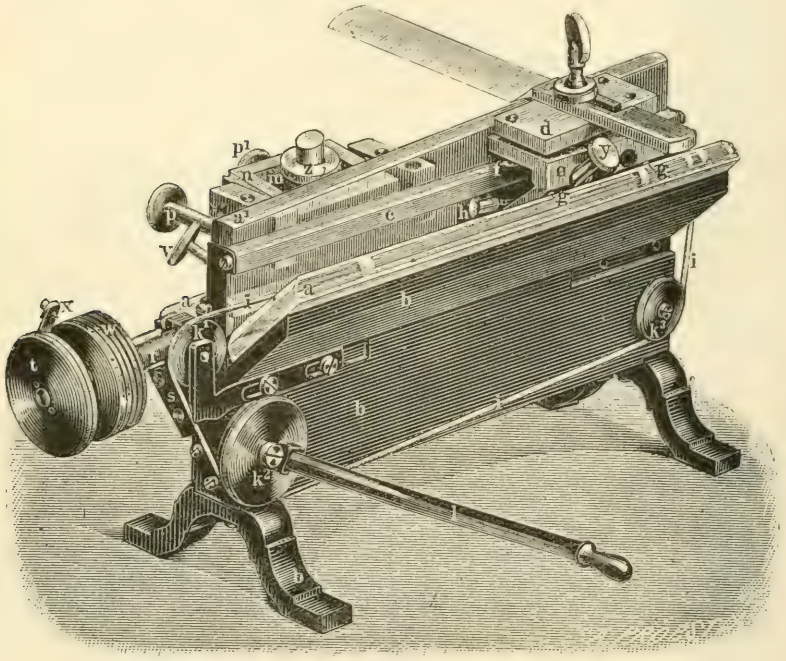
Imbedding Media for Diatoms.†—Mr. J. Deby uses, as imbedding media for diatoms, chloride of zinc or chloride of magnesia mixed with their respective oxides. As soon as the mixtures have become hard, thin sections can be made in the same way as with ordinary rock. If sufficient care is taken, it is not difficult to obtain sections of a less diameter than the areola of a *Triceratium* or of a *Coscinodiscus*.

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 320–5.
† Journ. Quek. Micr. Club, ii. (1886) pp. 308–9.

Becker's Sliding Microtome.*—Dr. J. W. Spengel describes an improved form of sliding microtome (fig. 181) devised by him in conjunction with Herr A. Becker, who is also responsible for the workmanship.

In general aspect and in principle it resembles its predecessors of the same type, the Rivet, Thoma-Jung, &c., while the novelty of its details gives it its characteristic features. For instance, the slide-ways are made of plate glass, which allows a perfectly free and even to and fro motion of the slide or carrier without the aid of any lubricant. The stand *b* is made of cast iron. The side-plates *a* are set on the middle plate *a'* at an angle of about 45°; greater

Fig. 181.



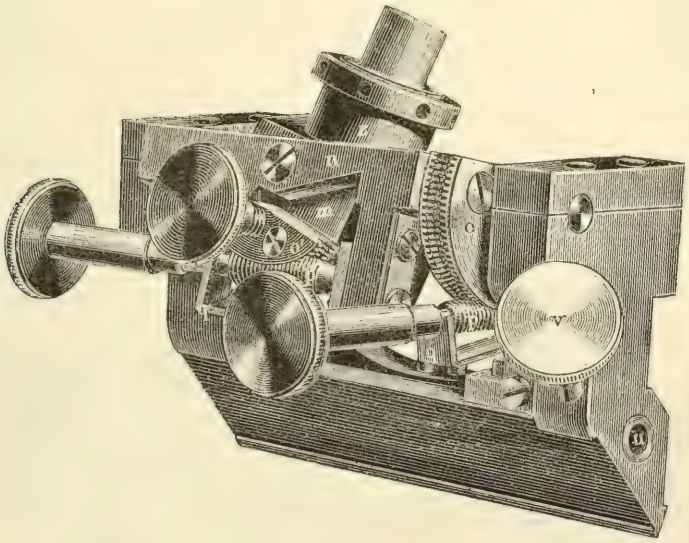
certainty being obtained at this angle than when the slide works at a less inclination, as in the Jung microtome. The firmness of the carrier's movement is increased by strong springs which work against the under surface of the longitudinal bar *c* fitted to the central plate. The knife-carrier is provided with an arrangement for altering the position of the knife. Its upper part, a plate *d*, does not rest

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 453–9 (2 figs.).

directly upon the body e but is separated from it by a small ball, around which it can be moved to the desired inclination, by means of three screws f. In order to lessen the friction of the carrier on the slide-ways, its under surface is fitted with four ivory points g, inserted as near the corners as possible, and in order to balance the resistance produced by the pressure of the springs, both ends are fitted with two small rollers h.

The uncertain results produced by machines worked by hand, and in which the slide-ways must be lubricated, are avoided by means of the following arrangement: a catgut band i runs from one end of the carrier over four rollers $k_1\, k_2\, k_3\, (k_4)$ to the other. k_2 is fitted with a winch handle l, by which it is easily turned. The catgut band is

Fig. 182.



not fastened directly to the carrier but to a wire, passing through the lower part thereof and fastened to it by a screw y.

The object-carrier is very similar to that first used by Jung. A short metal tube z is fastened by means of a binding-screw to the inner of the two frames. The inner frame turns about a transverse axis which has its bearing in the outer frame, and this latter turns round a longitudinal axis and the bearings are in the carrier. The ordinary complicated manœuvres for putting the object into a proper position, are in this machine effected by the turning of an endless screw. In each frame is a circular disc, or rather a section of one, $o\ o'$ fig. 182, along the edge of which a female screw-thread runs. Against this worm works a short screw $p\ p'$ which is braced up by a

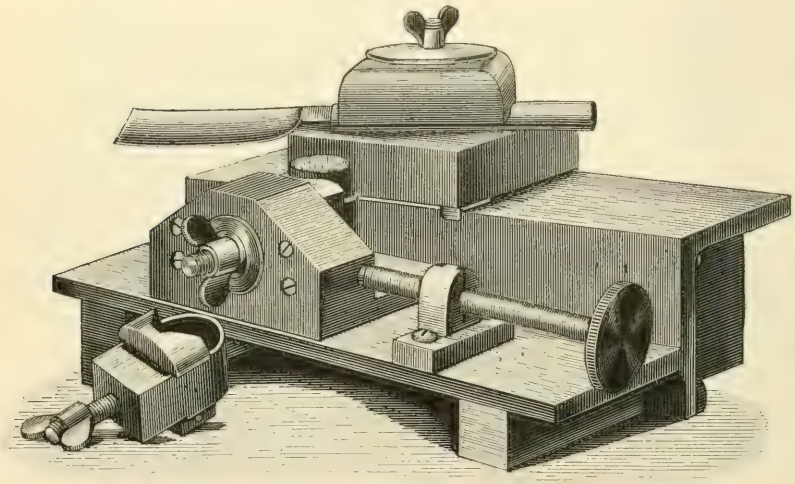
spring q q'. By working either of these screws, the corresponding frame turns on its axis.

A micrometer-screw r measuring 10 cm. serves to drive up the object-carrier. Its head t projects some way from the microtome, and may have any diameter. Communication between the front end of the screw and the carrier is obtained by means of a steel cylinder which passes through the opening u in the carrier, and which by means of a binding-screw v can be fixed at any point. The rotation of the screw is rendered audible by a catch x working on the barrel w. The latter has five divisions marking 1/2, 1/3, 1/5, 1/10, and 1/50 of a turn, which for corresponding sections gives a thickness of 1/40, 1/60, 1/100, 1/200, and 1/1000 mm.

Hildebrand's simple and effective Microtome.*—Dr. H. E. Hildebrand has devised a microtome of great simplicity and of small cost, and which he says equals in effectiveness any hitherto produced.

The body of the instrument (fig. 183) is of cast iron, 30 cm. long and 18 cm. broad. The upper aspect shows three surfaces,

Fig. 183.



which serve as slide-ways for the knife and object-carriers. The former moves along the upper or horizontal surface; the latter along the lower one which is sloped. The vertical surface is common to both, and prevents any lateral yielding. All three surfaces are planed perfectly smooth. On the lower part of the inclined plane is a female screw for the reception of a micrometer-screw with a large milled head. When the screw is turned, it pushes the object-carrier

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 313-5 (1 fig.).

forwards up the inclined plane. Each carrier runs on three ivory knobs. The knife-carrier is kept straight on the slide-way by means of two lateral flanges which work against the vertical plate. The object-carrier is fitted with two knobs which bear against this surface. The motion is very smooth and safe. Both carriers can be removed and replaced without losing their position. The knife-carrier consists of a flat support for the knife and of a clamp; it revolves round a central screw, and is provided with a groove below for the reception of the cylindrical knife-handle. In this way the knife can be adjusted both for its surface and longitudinal axis. The object-carrier consists of a simple block of wood provided with the above-mentioned projections, three below and two at the side. In the middle it has a 25 mm. opening for a binding-screw.

It is often desirable to place an object in a particular position, and this is provided for by a very simple screw clamp with universal movement. This is represented in the foreground of fig. 183. Although this apparatus is made in one piece (except the vice), it can be more easily described as if it consisted of several parts. A screw bolt with a head 25 mm. square is fitted with a metal loop, the ends of which are fastened to two sides of the square bolt for the reception of a movable block or vice, flat on the side turned towards the bolthead, and fluted towards the concavity of the loop. This clamp or vice is twice as long as it is broad. The arrangement of the object-carrier is as follows:—Upon the broad base (9 × 9 cm.) of this carrier, a block of such thickness is fastened vertically, that about three-fifths of the space towards the vertical surface remains free. This upright block is perforated for the reception of the above-mentioned bolt with its loop. Two-thirds of this perforation is of the same width as the diagonal measurement of the bolthead, so that this therefore can revolve within the round opening. The next, however, is wide enough to let the bolt itself pass through. If the cylindrical object-holder be placed between the vice and the loop, and the screw of the bolt turned, it will be firmly held, because the screw draws the loop but not the vice towards it. As the axes of the object-holder and of the screw clamp stand vertically towards each other, the object may be inclined in any direction. When used, the object-carrier is held with the thumb and index finger of the left hand, and pressure made backwards towards the micrometer-screw, and onwards towards the vertical plate.

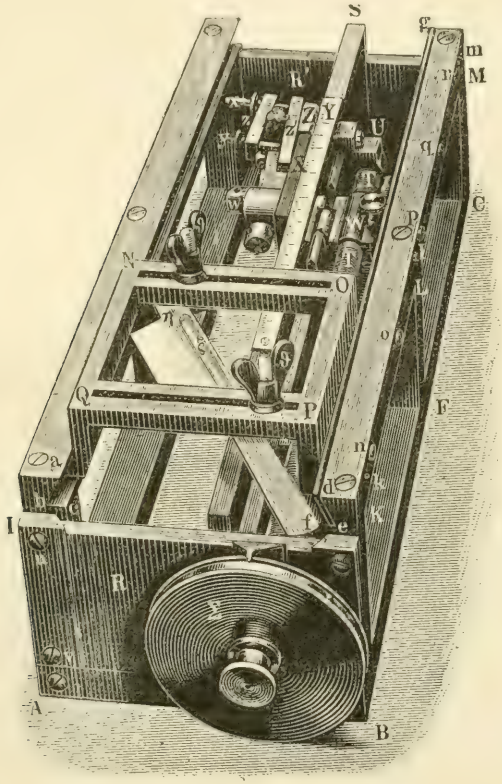
The author states, that with three microtomes which he has had made to this pattern, he has found that one complete turn of the micrometer-screw raises the object 1/500 in. (0·0508 mm.).

Vinassa's Microtome for Pharmacologists.*—The body of this instrument (figs. 184 and 185), invented by Dr. E. Vinassa, is formed by a heavy frame (1½ cm. square) A B C D, 45 cm. long and 18 cm. broad. The two longitudinal bars are joined in the middle and at the ends by three cross-bars A B, E F, D C, while at the corners and in the middle of the long sides are six supports, 12 cm. high, G D, H E,

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 309–20 (4 figs.).

I A, M C, L F, K B. All these parts are cast in one piece. To the supporting pillars two rails are screwed in on the long side, G I and M K, and which seen in transverse section show acute angled grooves *a b c*, in which the knife-carrier fits. One of these grooves *d e f*, *g h i* is planed out 5 to 7 mm. more to render it able to receive the carrier.

Fig. 184.

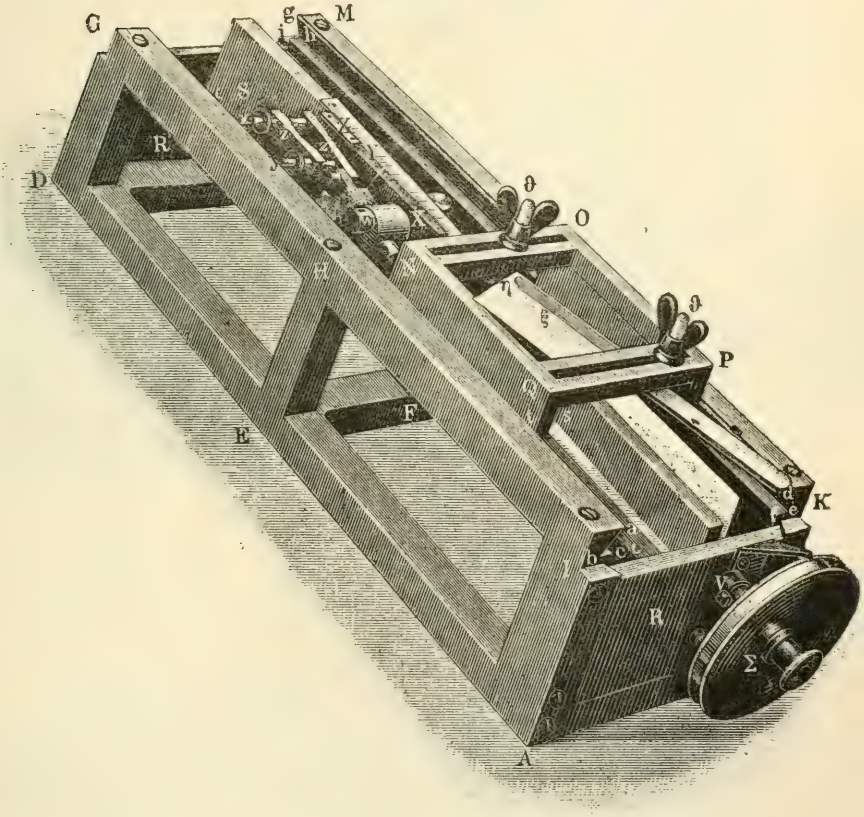


The interspace is filled up with a steel plate *e d g h i*, which, though movable on three pivots *k l m*, is fastened to the groove, and by five screws *n o p q r* on the outside can be fixed more or less tightly to the slide, whereby any irregular movement due to wear is prevented.

The sliding knife-carrier N O P Q is a frame 12 cm. long and 14 cm. broad; in both cross pieces (Q P and N O) is a slit for the binding-screws which clamp the knife to the under side of the carrier; by this arrangement the angle of the knife to the object can be altered at pleasure. To introduce the knife it is necessary that the under side of the carrier, the surface $s\,\alpha\,\beta\,\gamma$, should be 1·3 cm.

higher than the upper part of the slide-ways G T, M K. The lower part of the carrier which runs in the groove (*a b c* and *d e f*) is dovetailed to fit. The knife is fixed by two thumb-screws, which go through the slits in the cross-bars of the slide, and on its lower end is a clamping plate ϵ with a knob at one end δ. The object of this projection is to prevent the plate from getting broken by over-screwing up the knife. This consists of a strong handle 7 mm.

FIG. 185.

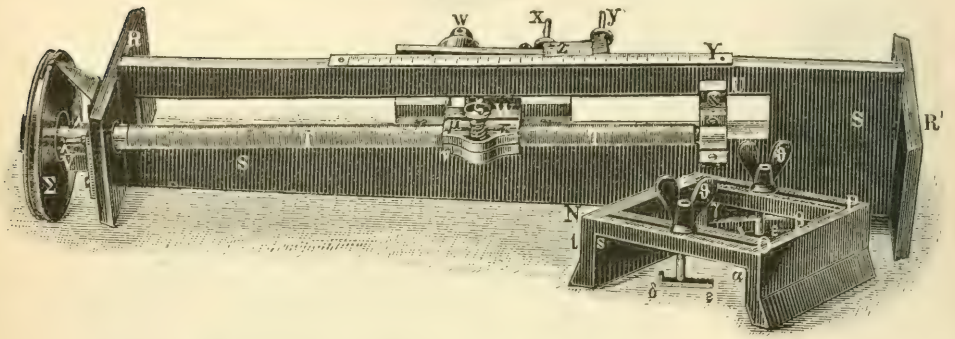


thick, of a broad blade ground like a scalpel, and which for the reception of fluid has a groove ξ near the back. On the upper part of the blade is a kind of second handle η, which, like the first, serves to fasten the knife by means of the clamp, and though of the same thickness, is only 3 cm. long. After raising the two thumb-screws θ, the knife can be easily removed from the carrier and sharpened like an ordinary razor.

At the short ends of the instrument are fitted two plates R and R', which are connected by a middle vertical plate S, 1 cm. thick, which serves to carry the object-holder. On one side is a wedge-shaped cleft t, ascending 5 per cent.; on this the object-carrier or slide X is supported. The object-carrier $x\,y\,z\,z'$ somewhat resembles that of Gottschau, but is modified in detail. As a coarse adjustment is of great advantage, Gottschau's clamp arrangement is so modified that the screws themselves act as axes. The screw ω, which allows the pincers to move vertically in a plane parallel to the middle wall, fits into a dovetailed tenon moving upwards and downwards $2\frac{1}{2}$ cm. in a groove in the carrier; turning the screw raises the pincers vertically.

The long microtome-screw T for raising the slide lies parallel to and outside the middle vertical wall. Its supporting points are at U

Fig. 186.



and V. It traverses a middle piece, which is united to the carrier, and is worked by means of two dovetailed parts which through the screw can be pushed up the inclined plane in a slit (ascending 5 per cent.) in the middle piece. Backlash is avoided by a special arrangement of two tightening screws $\lambda\,\lambda$ at V. The screw is turned by a milled head Σ with ten divisions. One turn pushes up the slide 1 mm., raising the object 0·05 mm. A small spring catch clicks for every thickness of 0·005 mm. The middle piece W through which the long micrometer-screw passes, opens by means of a horizontal joint $\mu\,\nu$, and is kept fastened by the screw ζ. Any inequality in the motion of the long lever screw is prevented by means of a spring π, which presses the jointed divisions $\mu\,\nu$ together. A thick screw (14 mm. diameter) is chosen, because it is easier to work and less liable to bend. On the middle wall S a millimetre scale 20 cm. long is screwed on at Y with a vernier Z. Measurements as fine as 0·005 mm. are made by means of a vernier fixed to the carrier.

Weigert's Immersion Microtome for large Sections.*—Prof. C. Weigert has adapted the Gudden microtome for cutting sections

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 326–33 (2 figs.).

FIG. 187.

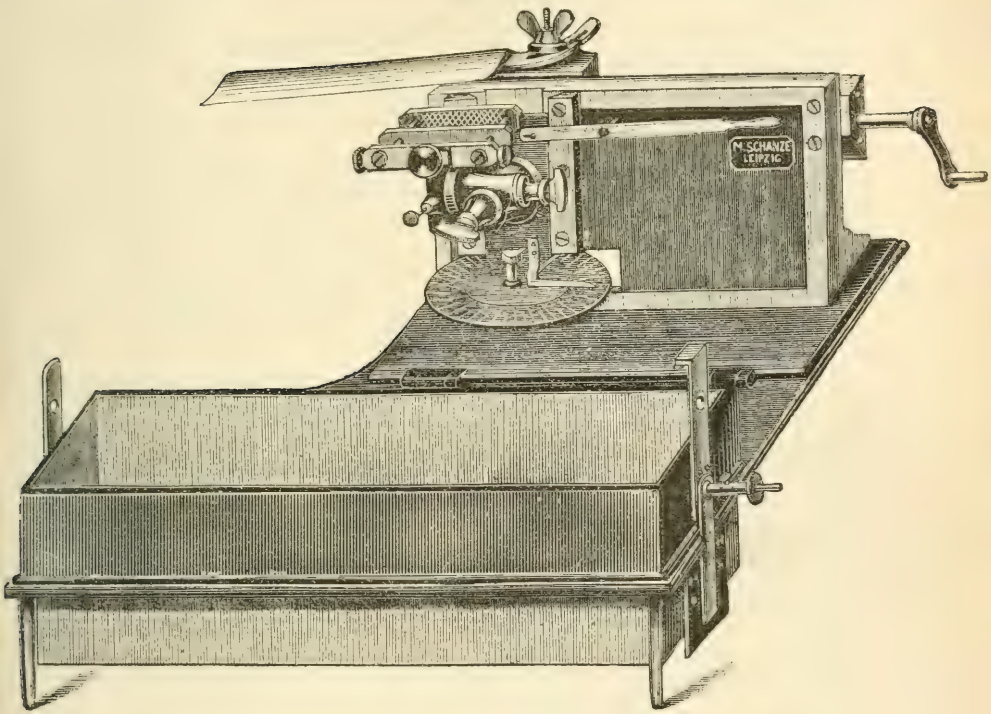
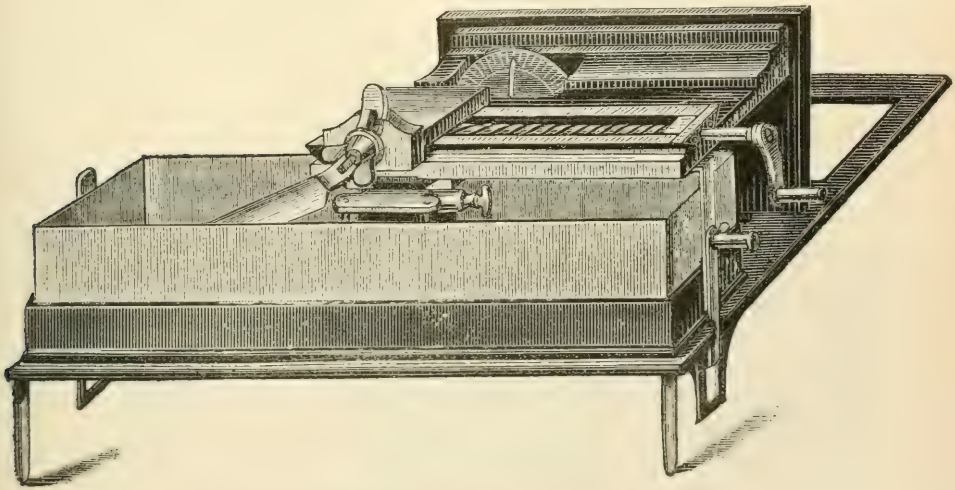


FIG. 188.



WEIGERT'S IMMERSION MICROTOME FOR LARGE SECTIONS.

under alcohol on a principle analogous to that which Prof. Malassez introduced in his modification of the Roy Microtome. That is, the instrument when used for immersion cutting is merely turned over on its side, so that it is at right angles to the position it occupied when used for dry cutting. Figs. 187 and 188, representing the instrument in both the positions in which it is used, are sufficient to explain the way in which the instrument works.

The microtome is chiefly intended for large sections, and is apparently able to produce thinner ones than can be obtained by the Katsch machine, the prototype of immersion microtomes.

Microtome Knives.*—Dr. A. Brass points out that the *sine quâ non* for producing good sections is the knife, for with an indifferent machine and a good and well-sharpened knife, better results will be obtained than with an indifferent knife and a highly complicated instrument such as the Thoma-Jung microtome.

For ordinary purposes the author uses a short knife made of very hard steel. It is quite straight, 14 cm. long (8 cm. blade, 6 cm. handle). The blade is 20 mm. broad and the back 5 mm. thick. The under surface, continued into the handle, is flat and the upper surface hollow-ground. When used it is worked at an angle of about 10° to the surface to be cut. The knife is sharpened by means of a special apparatus, the section of which is represented in fig. 189. The wooden block *h*, made of ash, is prismatic in shape, with a central slit for the reception of the blade *m*, and is so constructed that the cutting edge shall move against the hone *s*, at the same angle

Fig. 189.

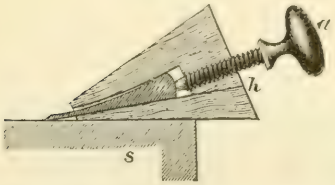


Fig. 190.

as when used for cutting. The blade is fixed in the slit by two screws *a*, 5 cm. apart. By this contrivance the edge is rendered wedge-shaped, and it is this characteristic which, the author thinks, gives it its value.

From fig. 190, giving a view of the knife *m* in operation, may be gathered the relation of the knife to the object *o* and the section *s'*, and also the exact shape of the knife. After sharpening on the hone, the finishing touches are imparted to the edge on the regulator strop, so condemned by Gottschau.

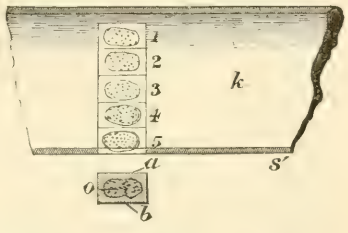
Preparing Adhering Series of Sections.†—For saving time in the preparation of series of sections Dr. A. Brass advises the method

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 305–7 (2 figs.).
† Ibid., pp. 307–8 (1 fig.).

known as riband cutting, in which the sections, while still on the knife, are made to adhere together by their adjacent edges, so that a chain of sections in perfect continuity is produced.

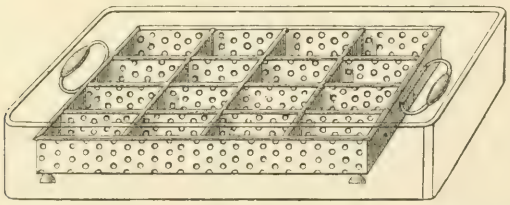
In order to effect this the objects must not be too large ; not more than 3 or 4 mm. long or broad; they must be imbedded in paraffin and the form of the imbedding mass must be rectangular, as shown in *o*, fig. 191. The knife *k* should be placed at right angles to the long axis of the microtome, the same part of the edge *s'* being used throughout; the paraffin mass must be so cut that the two surfaces *a* and *b* lie parallel to the edge of the knife. The more accurately this is carried out the better the sections adhere. A rapid to and fro motion of the knife is recommended as being likely to produce better sections and also cause the edges to adhere better. When a sufficient number of sections have been thus obtained the chain may be laid upon smooth white paper strips and then cut up into any desired length. Schanze's microtomes are said to be more suitable for riband cutting than Jung's, because the preparation always remains in the same position, is raised by a screw, and the knife can be placed over the same surface. With dexterity it is not difficult to make two sections a second.

Fig. 191.



Apparatus for facilitating the preparation of Serial Sections.*— In order to facilitate the manipulation of series of sections, especially of the nervous system, Dr. M. v. Lenhossék has constructed a tray of perforated zinc, fig. 192, and subdivided into a number of compart-

Fig. 192.



ments. Though the number and dimensions of these compartments may be varied, the author's apparatus has sixteen compartments, the diameters of which are 4 cm., and the depth about 1·5 cm. It is also provided with two handles and four knob feet. If required for watery solutions, the zinc may be japanned; if for alcoholic, it is advisable to leave the metal in its natural condition.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 53-5 (1 fig.).

The method of using the apparatus is obvious from the illustration, which shows the tray standing within a glass dish. Water or fluids for staining, &c., are simply poured in until the tray is almost covered, and when any one step is finished, it is merely necessary to lift out the tray, the fluid draining away, while the sections remain within the compartments. Of course, it is not advisable to proceed to the stages of absolute alcohol, oil of cloves, &c., by this method. The tray, when in use, should be covered with a glass plate.

Method for retaining Series of Sections in position.*—Herr H. Gifford records a device which he calls the "book method" for keeping series of sections attached *in situ*. This merely consists in not quite cutting through the celloidin imbedding block, leaving a margin of 6 to 7 mm., so that a number of sections resemble a book, and may be turned over like the leaves. It will be found advantageous to make "books" of ten to twenty leaves. These "parts" or "numbers" may afterwards be bound together properly ticketed, and kept in spirit until required for use. A book or a part may be stained by merely suspending it by its back in the staining fluid. Should the imbedding or the knife be faulty, it sometimes happens that a section or leaf is cut out, i. e. without being attached to the back. In this event, a note should be made of the position of the section on the end of a strip of paper and the section fished out on it.

The great advantage of this method is its rapidity, and it does not require any additional apparatus. It need scarcely be observed that the microtome used should be an "immersion" one.

Heidenhain's Staining Method.†—Prof. R. Heidenhain finds that the following slight modification of his well-known staining method yields the most beautiful results.

Tissues hardened in alcohol, or better in a saturated solution of picric acid first and then in alcohol, are left for 12–24 hours in an aqueous solution of hæmatoxylin (1/3 per cent.), and then placed for 12–24 hours in 1/2 per cent. solution of *simple yellow chromate of potassium* (instead of the red double chromate). The usual dehydration with alcohol, penetration with xylol, and imbedding in paraffin, follow.

"Simplification of Staining."‡—Dr. W. Kükenthal's results with staining solutions in turpentine oil are as follows:—

Ammotrypane binacina Rathke (killed in alcohol) were stained with Grenacher's borax carmine (then absolute alcohol, toluol, paraffin, collodion, oil of cloves, and removal of paraffin with turpentine), and were finally placed in a vessel containing turpentine, to which some methyl-green and some drops of a solution of picric acid in absolute alcohol have been added. Result, nuclei red; plasma-

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 45–7.

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 383–4.

‡ SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1885. Zool. Anzeig., ix. (1886) pp. 23–5. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 80–1.

substance green; nervous tissue clearly differentiated. Eosin, gentian-violet, methyl-blue, safranin, fuchsin, tropæolin, malachite-green, and Bismarck brown may be used instead of methyl-green.

If the sections treated with turpentine stains are put in a mixture of pure turpentine oil and absolute alcohol, the colour slowly fades from the plasma. The author used Mayer's carmine solution, the formula for which he communicates as follows:—100 cc. of absolute alcohol are boiled with four grm. carmine and twenty-five drops of hydrochloric acid added. This solution is placed drop by drop in a mixture of turpentine oil and absolute alcohol, and the turpentine oil to be used is mixed with it. Staining is almost instantaneous. Double staining is possible. Hæmatoxylin powder dissolved in absolute alcohol and introduced in turpentine oil gives a nuclear stain. The bright brown nuclei assume a violet colour in ammonia vapour. The absolute alcohol must be pure and free from acid. The turpentine colours are to be kept in glass bottles.

Isolating the Primitive Muscular Bundles and Staining Nerve-endings.*—Dr. G. Sandmann gives a new procedure for isolating the primitive muscular bundles and for staining nerve-endings.

For isolation the author employs a solution of sulphuric acid and distilled water. The muscles are put with the acid in a test-tube, either in toto, or if their size require it, are dissociated in pieces parallel to the fibrillation. Here they remain from one to eight days according to their thickness or richness in connective tissue. The muscles are then washed, and boiled several times in distilled water. Before each boiling it is necessary to allow the water to cool or to replace the hot with cold water, since the glue formed from the connective tissue through the heat and acid loses its coagulability and becomes easily soluble in water. Muscles thus treated are easily dissociated throughout their whole length into their primitive fibrillæ.

In staining, for which purpose Dr. Sandmann uses gold chloride, he departs from the usually accepted view that only fresh muscle-fibre gives good gold preparations, and exposes muscle-fibres treated with sulphuric acid to the influence of the gold chloride. He lays the separated muscle-fibres in a dilute gold solution (one to three drops of a 1 per cent. gold chloride solution to 10 cc. water) until they take on a yellow colour. After having been washed several times in water acidulated with acetic acid, the muscle-fibres are boiled for a few minutes in order to cause the reduction of the gold. The muscle-substance becomes of a red to a deep-blue colour, the nerves are darker, even black.

As in all gold staining, this method has the defect of inconstancy of stain, but from its easy practicability, it permits, without trouble and waste of time, the preparation of a large number of specimens, among which some few will always be found well stained. The method gave very favourable results in the examination of mammalian muscular fibres, which are only dissociated with difficulty, and also in the study of degenerative changes of nerve-end apparatus.

* Arch. f. Anat. u. Physiol.—Physiol. Abth., 1885, *p.* 240.

Staining black the processes from Ganglion-cells.*—Dr. C. Golgi's method is said to give very excellent results.

Pieces of cerebellum or medulla from 1 to 1½ cm. in size are hardened in a 2 per cent. bichromate of potash solution. The strength of this may afterwards be increased to 3 per cent. Six or eight days suffice (but it is better to wait twenty to thirty days) to obtain the necessary hardness, the bichromate solution being frequently changed. The pieces are then placed in 0·5 or 0·25 to 1 per cent. solution of perchloride of mercury, wherein they may remain for at least two months.

The author further describes successive staining with potassium bichromate or ammonium bichromate and 0·75 per cent. silver nitrate solution, or with a mixture of 8 parts 2–2·5 per cent. bichromate, and 2 parts 1 per cent. hyperosmic acid.

Bizzozero's Picrocarmine.†—Dr. G. Martinotti desires to correct the words in the original notice ‡ (heated in a water-bath) "until one no longer perceives even the slightest ammoniacal odour," for "until a slight but evident ammoniacal odour is perceived."

Methyl-blue.§—Dr. P. Ehrlich, in order to determine the receptivity of animal tissue for oxygen, injected into the veins of rabbits large quantities of a dilute solution of methyl-blue, and found that as with alizarin, the majority of the organs showed more or less strong primary staining, while in some, such as the liver and lungs, the pigment became changed by oxidation to white. Methyl-blue takes a place about half-way between; alizarin and indophenol being more easily reducible than the latter, and with rather more difficulty than the former. Post-mortem reduction takes place extraordinarily quickly, perhaps as rapidly as with indophenol, and it is therefore advisable to inspect the organs as soon as possible, even while the animal is alive.

Anilin-blue-black.‖—Dr. G. Jelgersma in defending anilin-blue-black from the attacks recently made upon it, recommends the English-made dye, from which he has always obtained most satisfactory results.

1. The preparations are permanent; specimens exposed to full daylight for over a year have not deteriorated.

2. Anilin-blue-black is specially adapted for nervous tissue, axis-cylinders, ganglion-cells and their processes. In preparations of the cortex cerebri et cerebelli, Purkinje's cells, with their processes, are seen branching as far as the periphery. Pathological changes in the ganglion-cells are most easily observed in this stain. The axis-cylinders become dark-blue and easiest recognized in vertical section, although in oblique and parallel directions they are very clear.

* Cf. Virchow and Hirsch's Jahresber. Anat. u. Physiol. for 1885 (1886) p. 38.

† Zeitschr. f. Wiss. Mikr., iii. (1886) p. 57.

‡ Ibid., ii. (1885) p. 539. See this Journal, *ante*, p. 350, where the words are, "until every trace of ammonia has disappeared."

§ Centralbl. f. d. Med. Wiss., 1885. pp. 113–7.

‖ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 39–40.

Ganglion-cells become bright blue; the nuclei and nucleoli dark blue, the processes as well as the cell-body being stained.

3. Anilin-blue-black is of no value for connective tissue and the neuroglia; for these the author uses alum-cochineal, hæmatoxylin, or the Böttcher-Hermann anilin dye method.

4. The staining solutions are very simple. The author uses three watery solutions, 1 in 100, 1 in 800, and 1 in 2000, which stain in four, five, and twelve hours respectively. Then alcohol, oil, and balsam.

5. Anilin-blue-black tires the eyes much less than carmine, an advantage not to be undervalued when a large number of serial sections are to be compared.

Anilin-green.—Dr. P. Schiefferdecker's first communication * on this subject was to the effect that solutions of anilin-green undergo a certain change of composition from exposure to light, in virtue of which alteration they acquire a peculiar susceptibility for staining gland-tissue. This peculiar change cannot be effected in any other way than by age and exposure to light; the addition of alkalies or acids, the aid of gentle heat and various degrees of concentration, make no difference in the capacity of a fresh solution.

Since the first communication, the author has made experiments,† in order to obtain a record of the time the blackish-green reaction takes to develope. In twelve months a solution of anilin-green gave results which were about half-way between those of the seven-year old solution, and of the solution freshly made. Iodine-green, malachite-green, emerald-green, and several methyl-greens, were used in the course of the author's investigations on the salivary glands. But one methyl-green, prepared by the Stuttgart Anilin-Soda-Fabrik, and designated O O, produced in fresh solution results very similar to those from the old solutions. The author thinks the blackish-green reaction of anilin-green to be quite specific and of great value.

Anilin-greens may be mixed with eosin, so as to stain a preparation red and green simultaneously. The double stain is made by allowing some alcoholic eosin solution to dry up in a watchglass and then to add the anilin-green solution. By this method so much eosin is taken up as is necessary to combine with the anilin-green for the production of a double stain. Methyl-green O O gives similar good results.

Modification of the Formula for Alum-Carmine.‡—Dr. Pisenti recommends the following modification of the formula for the alum carmine first introduced by Grenacher. In 100 c.cm. of a hot saturated watery solution of alum (100 parts boiling water dissolve 133 parts crystallized alum) 1·5 to 2 grm. carmine are allowed to boil for a few minutes; 2 grm. of sulphate of soda are then added. This dissolves the small residue of carmine which the alum solution has left undissolved. It is then boiled again for five minutes and filtered while hot. The fluid is then allowed to cool, and as a considerable

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 51–3. † Ibid., iii. (1886) pp. 41–3.
‡ Gazzetta degli Ospitali, 1885, No. 24. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) p. 376.

quantity of alum crystals fall down, it is advisable to decant the solution and preserve in another bottle.

According to the author, this carmine stains microscopical sections in a few minutes, and the nuclei stand out quite conspicuously against the prettily stained protoplasm. It may also be used for staining *en masse* preparations for paraffin imbedding. Staining *en bloc* usually takes from 12 to 24 hours, although the size of the preparation and its histological construction modify these limits considerably. This carmine is said to possess the advantage of keeping for a long time without growing mouldy.

Weigert's Hæmatoxylin Stain.*—Dr. M. Flesch, with the co-operation of Dr. Berliner Blau, has succeeded in reducing the expense of the Weigert process by regenerating the once used staining solution. This is effected by adding 5 to 10 cm. baryta water to about 200 c.cm. of the used solution. The mixture having been shaken up several times is allowed to stand for 24 hours. Carbonic acid gas, made with hydrochloric acid and marble, is then passed through and after 24 hours is filtered. Stainings obtained from this filtered solution cannot be distinguished from those obtained with the original. An attempt was made to recover the pure dye, but this quite failed.

With regard to the copper modification,† the author now lays the separate sections on cellulose paper, whereon they are placed in the copper solution; from this they are transferred to a 70 per cent. spirit, and thence to the stain.

Dr. Flesch gives the preference to the copper acetate solution over his own chromic acid modification ‡ for fine nerve-fibres, but for nerve-cells, especially in peripheral ganglia, he has entirely given up the copper for chromic acid solution. The medulla of central and peripheral nerves is also much better demonstrated by the latter solution. Where deep staining is required he advises the use of the incubator, and instead of ordinary watchglasses, nests of glasses will be found more handy. For clearing up, he continues to find kreasote to possess advantages over other clarifiers.

Staining in toto the Central Nervous System with Weigert's Hæmatoxylin.§—Dr. C. E. Beever first hardens the preparation in methylated spirit, and then for one to four weeks in 3 per cent. potassium bichromate. He then changes to methylated spirit again, for one or two days, and next treats with hæmatoxylin for four days, raising the temperature every day for three or four hours to 40°–50° C. The hæmatoxylin solution was twice as strong as that used by Weigert (200 parts absolute alcohol, 2 parts hæmatoxylin, and 130 parts water). The pieces, having been washed, were transferred to a solution of potassium ferridcyanide, 2·5 parts; borax, 2 parts; water, 100 parts. The solution was changed until the browning disappeared, the pieces then were treated with water, methylated spirit, absolute alcohol, clove oil, and turpentine oil, imbedded in paraffin, freed from paraffin with xylol, and mounted in Canada balsam.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 50–1.
† See this Journal, *ante*, p. 710. ‡ Ibid., p. 709. § Brain, 1885, pp. 227–42.

New Method of Double-staining.*—Dr. A. Garbini uses two different solutions:—(1) Watery solution of anilin blue, 1 grm.; aq. dest., 100 c.cm.; abs. alcohol, 1–2 c.cm. (2) Safranin, 0·5 grm.; dist. water, 100 c.cm.; abs. alcohol, 50 c.cm. The sections, either free or fixed by Mayer's method to the slide, are immersed from one to four minutes in the first solution, then washed in water, and then laid in a 1 per cent. solution of ammonia until almost all the colour has disappeared. The sections are next placed for five to ten minutes in a 0·5 per cent. solution of hydrochloric acid, are then again washed in a large quantity of water, and are finally placed for four or five minutes in the second solution, from which they are transferred directly to absolute alcohol. Here the sections lose their violet colour to assume a sapphire blue hue. They are then passed through oil of cloves, xylol, and mounted in xylol balsam.

According to the author this method offers the following advantages:—It may be used for any animal or vegetable tissue, imparting to the individual elements their characteristic staining, and even to the different cells of an organ (delomorphous and adelomorphous cells, salivary and mucous cells), the protoplasm staining in various colours.

Merkel's Double Stain with Indigo and Carmine.†—For this safe and excellent stain Dr. M. Flesch uses material hardened in chromic acid or Müller's fluid, followed by immersion in alcohol. The alcohol treatment is proceeded with without previous washing in the dark; much time is thereby saved, and the preparation in no way loses any staining susceptibility. This procedure is especially recommended for nervous tissue, as the brown coloration, which is regarded by Weigert as indispensable for the success of his stain, never fails. The alcohol can be filtered and used over again, so that the cost is not very great. The author has usually experimented on objects imbedded in celloidin, but paraffin preparations previously saturated with turpentine or chloroform take on the stain. Unfortunately the celloidin is stained along with the preparation; the colour, however, with great care and prolonged washing gradually becomes so pale, that this disadvantage need scarcely be considered.

The dye is a mixture of the solutions of carmine (carmine 2, borax 8, H^2O 130) and indigo carmine (indigo-carmine and borax each 8, water 130) in equal parts. This mixture can be kept for a week: if kept longer, a precipitate forms, and the carmine acquires the disadvantage of staining too deeply.

The staining requires a much longer time than Bayerl stated. Textures should be left at least twenty-four hours in the solution at ordinary temperatures; one to two hours in an incubator. The author much prefers the former. After staining, the superfluous pigment is extracted by immersion for half an hour in a saturated solution of oxalic acid. It is always possible to render the water more blue or more red, according as the staining or extraction time are varied.

* Zool. Anzeig, ix. (1886) pp. 26–9.
† Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 349–52.

Preparations may be mounted in glycerin or in balsam, and are very permanent. The author has exposed objects frequently to the light in the course of the year, and has not noticed any loss of colour.

This method is especially suitable for nervous tissue and for ossifying cartilage, and may also be recommended for the examination of glands and glandular organs.

Watney's Double Stain with Hæmatoxylin.*—Dr. W. Krause recently reproduced † a procedure introduced by Watney ‡ for double staining by the exclusive use of hæmatoxylin. This is effected by successive staining with a strong red and a weak blue solution. The difference between the two solutions really depends on the quantity and acidity of the alum. An intense blue is obtained by the use of freshly prepared dry alum; the red colour appears when acid has gradually become free in the alum, but best when the quantity of the alum solution is less than three times the quantity of the wood-extract. Connective tissue, the protoplasm of the connective-tissue corpuscles, and the walls of vessels are stained red. Mucus, almost all nuclei, and lymph corpuscles, are stained blue.

A communication from Prof. Langhans to Dr. M. Flesch shows that this double stain takes place more simply if Delafield's hæmatoxylin be used in the ordinary way, and the preparations when mounted in Canada balsam are exposed to the light for a long time. Preparations mounted in glycerin are said to undergo this change.

Silvering Diatoms.§—In an article on "Photography in Belgium," an account is given of Dr. H. van Heurck's method of photographing *Amphipleura pellucida* and other diatoms, with a description of the apparatus ‖ and processes employed. The method of silvering the diatoms, for the purpose of making their details more perceptible, is also described.

The cleansed valves scattered over a disc of cover-glass are silvered, glass and all, with a silvering solution consisting of nitrate of silver 10 parts dissolved in 6·2 parts of strong liquid ammonia; after solution, 50 parts of distilled water are added, and the liquid is filtered; after filtration 800 parts of distilled water are added; this forms solution A. Solution B consists of 2·25 parts of tartaric acid previously exposed for a long time to sunlight; the acid is then dissolved in 8·5 parts of water. These solutions are mixed, drop by drop, with violent shaking, and after sufficient of B has been added to A to tend to produce a permanent precipitate, the silvering solution is made. The pieces of glass and diatoms to be silvered are placed upon the flat cover of a vessel containing boiling water, which water is kept at that temperature during the silvering operation,

* Zeitschr. f. Wiss. Mikr., ii. (1885) p. 353.

† Internat. Zeitschr. Anat. u. Histol., i. (1884) p. 154. *Infra*, p. 906.

‡ Phil. Trans., iii. (1882) p. 1075.

§ Engl. Mech., xlii. (1886) pp. 548–9, from Brit. Journ. of Photography.

‖ Swan incandescent electric lamp; Wenham's radial arm Microscope, and Nachet's large inverted Microscope with silvered mirror (principally); Zeiss's objectives; Powell's oil condenser.

which lasts for thirty minutes; some fresh silvering solution is then applied and allowed to act at the same temperature for another thirty minutes; by this means a somewhat thick coating is given.

Smith's new High-refractive Media.*—Prof. H. L. Smith writes as follows :—

"The results of experiments made subsequently to the discovery of the boro-glyceride and antimony bromide medium, described in a preceding paper,† are of importance, and demand a brief notice. The antimony compound works very pleasantly, and still appears to be the best when high refractive power is required; but unless all excess is completely removed from outside the cover, it stains the protecting ring. The litharge and gold size ring and the zinc white ring are merely darkened; but the black asphalte ring is softened. Thoroughly cleaning off the excess around the cover remedies this difficulty.

The chief improvement I would make in the formula given, I now think, is the substituting of stannous chloride for antimony bromide, and of arsenious acid for boracic acid.

I find that a compound of stannous chloride, arsenious acid, and glycerin is so very slightly deliquescent, that the mounts may be left for weeks without cleaning off the excess, and that very little if any softening of the material ensues. The mounts are easily cleaned, as the cover is very firmly attached.

The medium is not so liable to turn when heat is applied, as when boro-glyceride or gelatin and glycerin are used; the latter, indeed, for that reason, is quite objectionable. The refractive power of the mixture is not quite so high as when antimony bromide is employed; but the refractive power is quite high enough for anything except the most hyaline tests; and as a little excess of material outside the cover does not discolour the ring, and does not seem to alter by quite long standing without a ring, I now prefer this compound.

This medium is prepared as follows:—Weigh out 6 parts of stannous chloride, and 2 to 2½ parts of pure arsenious acid. Melt the stannous chloride in a test-tube, and boil it for a little while; add while hot an amount of glycerin equal to the bulk of the melted stannous chloride, not more; heat and shake until it forms a perfectly clear solution. Add now, little by little, the arsenious acid, constantly shaking and heating until all is dissolved. This mixture when cold should be very viscid.

In making a preparation with this medium, at first, on heating, a great number of small bubbles may appear under the cover. A little more heating enlarges these to steam-bubbles; then, by allowing the slide to cool a little, the cover will settle down, and most of the bubbles will disappear; but if any are still present, another application of the heat of a small flame under the slide at the edge of the cover, where the bubbles are most abundant, will remove them.

* Journ. New York Micr. Soc., ii. (1886) pp. 75–7.

† See this Journal, *ante*, p. 356.

Towards the completion of the preparation, the slide may be inverted, if necessary, and the small flame allowed to play directly on the edge of the cover; thus, careful treatment will dispose of all bubbles. When cold, the excess is easily removed with a moistened roll of tissue paper; and finally, after the cleansing, the slide should be warmed just sufficiently to expel any moisture that may have found its way under the cover. If, after the ring is applied, and the preparation otherwise completed, any metallic stain should show on the cover or slide, it can be removed with a roll of tissue paper moistened with hydrochloric acid.

The arsenious acid also makes an excellent compound with the antimony bromide; and the highest-refractive-power white medium that I have yet seen is made as follows:—Melt antimony bromide and add to it while hot half its bulk of glycerin; in this put arsenious acid, little by little, shaking and heating at the same time, until by its solution the bulk is increased three-fourths of one part, so that the final mixture will be: antimony bromide 2 parts, glycerin 1 part, arsenious acid 3/4 part, all in bulk. This compound is solid, or very nearly so, when cold, and will require slight warming to take out a drop on the dipping-rod. It does not soften much, if at all, on exposure, and its refractive index is well on towards 2. The mounts made with this material are very satisfactory.

Finally, I think that the yellow medium, the compound of 'realgar' and bromide of arsenic, can be made permanent and easy to use by the addition of a small excess of sulphur. The realgar is broken up and dissolved by the aid of heat, in the bromide of arsenic. The solution is evaporated until, when cold, it becomes so viscid as to flow with difficulty; enough sulphur is now added to increase its bulk about one-sixth (I have not been able to determine the exact proportions yet), and thoroughly dissolved; it becomes now somewhat more limpid, and is used as one would use balsam. It requires a very light heat to boil, so the slide must be heated cautiously; but there is no difficulty in boiling, and this should be continued for a little while, when the cover will settle down entirely free from bubbles, and, if the user is careful not to slide it, may be gently pressed down. When cold, the deep colour will disappear and the cover will be very firmly fixed. To use this medium, the best polished slides must be obtained, as all the pits and scratches of ordinary slides show up very disagreeably. The cover also must be well cleaned. I have preparations which were made with this material more than three months ago, that show no symptoms of change.

Too much sulphur, however, will, in time, crystallize. I cannot now state what proportions can be safely used, but the amount named above, thus far appears within limits."

At the meeting of the Microscopical Section of the Royal Society of New South Wales on June 2nd,* specimens of *Amphipleura pellucida* were exhibited mounted in piperine, picric acid, chlorides of tin and thallium and sulphur in combination with disulphide of

* Cf. Nature, xxxiv. (1886) p. 355.

arsenic. "These slides were exhaustively tested against the American methods, viz. Dr. Chase's metallic silver and realgar, also Prof. Smith's specimen slide. . . . The slide of Dr. Morris's sulphur and arsenic combination gave the best results."

Wax for Cells.*—Mr. C. M. Vorce recently found that while a considerable number of cells in his collection had gone wrong, not one of the wax cells or wax-bottomed curtain ring cells (described Amer. Mon. Micr. Journ., i. (1880) p. 208) was found loose.

Acting on the hint gathered from the durability of the wax cell mounts the damaged slides were repaired in the following manner:—The Atwood cells, and other loose cells having their covers still attached, were cleaned of the old cement and the slip cleaned anew, and placing the cell on a sheet of coloured wax, it was cut round with a penknife, and, with the disc of wax adhering, transferred to the slip and centered on the turntable, and slightly pressed to fix it in place. The slip was then placed on the warming table and gently heated till the wax slowly melted, when the excess exuded as a coloured ring around the cell. The slide was then returned to the turntable, and a ring of transparent cement spun around it over the wax. Gold size, Bell's cement, liquid marine glue, Brown's rubber cement, or Folsom's finishing cement, are all good for this purpose, and when dry the slide is complete.

In the case of loose covers, the top of the cell was cleaned of cement by means of knife and turntable, a cover was selected or cut of a size slightly smaller than the outer diameter of the cell, and placed on the cell; warm (not melted) wax was then filled into the space between cover and outer edge of cell by means of a knife-blade, and finally smoothed by the same means on the turntable. Finishing cement was then applied over the wax from inner edge of cell down to and upon the slide, and the mount was complete.

Mr. Vorce also writes, "My own experience leads me to conclude that the condemnation of wax cells and the use of wax on account of the sweating so common when it is used was premature. A wax cell with a covering layer of cement, if used when freshly made, will frequently sweat; but if well seasoned will scarcely ever sweat, according to my experience. The wax appears to soften some cements, probably because they contain some solvent of the wax, and these will sweat no matter how old, unless years be allowed for seasoning; hence, cements containing turpentine or oil should not be used for covering wax cells; but benzole being so volatile will wholly leave the wax in a few weeks, hence, as well as on account of its colour, I generally employ Brunswick black.

"The cells made as advocated in the article referred to have this advantage, that the slide may be left (and freely used) with no other cement than the primary wax filling around the edge of cover for months or years, until it is seen whether any sweating will occur. If it does occur, by placing the slide on a turntable the wax filling can be instantly turned out with a sharp-pointed knife-blade, the cover

* Amer. Mon. Micr. Journ., vii. (1886) pp. 123–4.

freed, object removed, and cell recoated, or the cover simply cleaned and replaced as before in a minute or two, and thus objects too hastily mounted may be remounted or recovered with the least loss of time, which cannot be done so well or so quickly where covers have been cemented down with any of the cements ordinarily used."

Mr. R. Hitchcock has found, however, that since he has been in Washington a great change has taken place in his slides, and that the covers are now quite generally coated with the deposit complained of. It should be remembered that in this case the mounts remained in a perfect condition certainly four or five years, and then the change took place.

The Microscope in Mineralogy.*—Prof. J. W. Judd writes as follows :—

The recognition of certain characters in the rock-forming minerals as being original and essential, and the distinction of such from other characters which are secondary and accidental, is of the highest importance to the petrographer and geologist, and not less so to the mineralogist. Rightly studied, these minerals are capable of furnishing the geologist with evidence not only concerning the mode of origin of the rocks of which they form a part, but also of the changes which they have undergone since their first formation. The study of the minerals included in the crystalline rocks is not less important than that of fossils in the sedimentary rocks. And to the mineralogist the study of the secondary characters of minerals, and of the causes which have produced them, is equally necessary. Researches of this kind, indeed, can scarcely fail in the end to reduce many so-called mineral species to the rank of accidental, though still highly interesting varieties.

But of still greater importance is the recognition of the fact that the investigation by the aid of the Microscope of the processes by which minerals have acquired their several characters, and the consequent tracing of the evolution of mineral species and varieties, is calculated to raise mineralogy from its present rank as a merely classificatory science, to infuse it with new life, to open out to it new realms of research, and to invest it with a higher importance than is at present accorded to it in the family of sciences.

Amphipleura pellucida in various mounting media. [*Supra*, p. 902.]
Nature, XXIV. (1886) p. 355 (Proceedings of R. Soc. N. S. Wales, June 2nd, 1886.)

Bachmann, E.—**Mikrochemische Reactionen auf Flechtenstoffe als Hülfsmittel zum Bestimmen von Flechten.** (Micro-chemical reactions of Lichen-substance as an aid to the determination of the Lichens.) [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 216–9.

[Beck, J. D.]—**New Methods and Mailing-boxes.**
["This method of double-staining vegetable sections consists in employing such means whereby it is possible after staining to dehydrate the sections in absolute alcohol without having the colour in the least removed by the alcohol. Mr. Beck 'does not feel able to give the process to the public,

* Quart. Journ. Geol. Soc., xli. (1885) p. 411.

but will sell the same to private parties, including one slide, for 75 cents.'" The box consists of a block of wood the length of a slide and any width desired. Grooves are sawn lengthwise nearly through the block for the reception of the slides. A semicircular or U-shaped groove is cut through the centre of the block transversely to the grooves above-mentioned. It leaves a clear place for the mount on the slide. The box is easily made, and its cost is nominal.]

The Microscope, VI. (1886) pp. 177-8.

Becker, A.—**Neuerung an Mikrotomen.** (Improvement in microtomes.)

[Same as *supra*, p. 884.]

German patent, No. 34,683, 20th September, 1885.

See *Zeitschr. f. Instrumentenk.*, VI. (1886) pp. 218–9 (2 figs.).

,, ,, See also Huber, K.

Benda, C.—**Ueber eine neue Färbemethode des Centralnervensystems, und Theoretisches über Hæmatoxylinfärbungen.** (On a new method of staining the central nervous system, and theoretical remarks on hæmatoxylin staining.)

[Original of *ante*, p. 728. *Post.*]

Arch. f. Anat. u. Physiol.—Physiol. Abtheil., 1886, pp. 562–4.

Benecke, F.—**Anleitung zur mikroskopischen Untersuchung der Kraftfuttermittel auf Verfälschungen und Verunreinigungen.** Für die Praxis bearbeitet. (Guide to the microscopical investigation of adulterations and impurities of oil, flour, bran, &c.). [*Post.*] vi. and 117 pp., 44 figs. (8vo, Berlin, 1886).

Braun, M.—**Zur Behandlung der Anthozoen.** (On the treatment of Anthozoa.) [*Post.*] *Zool. Anzeig.*, IX. (1886) pp. 458–9.

Brevoort, H. L.—**[Microscopical Examination of Cotton Fibre.]**

Journ. New York Micr. Soc., II. (1886) p. 81 (2 figs.).

Brock, J.—**Technische Notizen.** (Technical Notes.)

[Recommends the dorsal spine of the male Triton as a suitable object for demonstrating cell-division.—Double staining of the pallial wall of Pulmonata with borax-carmine and hæmatoxylin; pigment glands red, mucous glands red, epithelium, muscle, connective tissue, violet of various shades.—As a maceration medium for the isolation of nervous elements of marine molluscs; bichromate of potash in 10 per cent. solution and diluted with an equal volume of the fluid from the somatic cavity of the animal (12 hours).

Internat. Monatsschr. f. Anat. u. Histol., I. (1884) p. 349.

Buffham, T. H.—**[Preserving Marine Algæ.]**

[Wash well in sea-water and put in best glycerin, or, as in the case of *Polysiphonia* and allied species, in a saturated solution of common salt. Mount in Deane's gelatin.]

Journ. Quek. Micr. Club, II. (1886) pp. 342–3.

Castellarnau y de Lleopart, J. M. de.—**Procédés pour l'examen microscopique et la conservation des animaux à la station zoologique de Naples.** (Methods for the microscopical examination and preservation of animals at the Naples Zoological Station.) (*Continued.*)

[Transl. by Dr. J. Pelletan of the second part of the report noted Vol. V., 1885, p. 746.]

Journ. de Microgr., X. (1886) p. 69–75, 178–84, 274–9, 368–72.

Cole, A. C.—**Studies in Microscopical Science.** Vol. IV. Nos. 1 and 2 (each 4 pp.).

Sect. I. Botanical Histology. No. 1. I. The Vegetable Cell. Plate I. Trans. Sec. through growing point of Fig. × 250. No. 2. II. The Cell-wall. Plate II.

Sect. II. Animal Histology. No. 1. The Mammalian Testis. Plate I. Testicle of Cat. Trans. Section × 200. No. 2. Spermatozoa of Vertebrata. Plate II.

Sect. III. Pathological Histology. Nos. 1 and 2. Normal Kidney. Plate I. Kidney. Plate II. Congestion of Kidney.

Sect. IV. Popular Histology. Nos. 1 and 2. The Sea Fans. Plate I. Spicula of *Gorgonia flabellata* × 200. Plate II. Spicula of *Thyone papillosa* × 250.

DEBY, J.—**On the Microscopical Structure of the Diatom Valve.**
[Imbedding media, *supra* p. 883. See also *post.*]
Journ. Quek. Micr. Club, II. (1886) pp. 308–18, 339–40.

EHRLICH, P.—**Zur Biologische Verwerthung des Methylenblau.** (On the biological value of methylen blue.)
[*Post.*] *Centralbl. Med. Wiss.*, 1885, pp. 113–7.

„ „ **Beiträge zur Theorie der Bacillen-färbung.** (Contributions to the theory of staining Bacilli.) 17 pp. (8vo, Berlin, 1886).

ÉTERNOD, A.—**Guide technique du Laboratoire d'Histologie normale et Eléments d'Histologie Générale.** (Guide to the technique of the laboratory of normal histology and elements of general histology.)
viii. and 246 pp., 53 figs. (8vo, Genève, 1886).

FIELD, A. G.—**Microscopy in Medicine.** *The Microscope*, VI. (1886) pp. 145–9.

FLEMMING, W.—**Surrogate für Knochenschliffe.** (Substitute for bone-grinding.)
[*Supra*, p. 876.] *Zeitschr. f. Wiss. Mikr.*, III. (1886) pp. 47–9.

GAGE, S. H.—**The Microscope in Jurisprudence.**
["While an *entire* human body may be distinguished as such with certainty, histological knowledge is not, in my opinion, sufficiently advanced at the present day to enable one to say that any microscopical structure is absolutely characteristic of and peculiar to a human being."]
Journ. New York Micr. Soc., II. (1886) p. 68, from *Notes on Histological Methods.*

Gierke, H.—**Staining Tissues in Microscopy. XI.**
[Transl. from *Zeitschr. f. Wiss. Mikr.*]
Amer. Mon. Micr. Journ., VII. (1886) p. 150–2.

GILES, G. W. M.—See Bibliography *a.*

HAUSHOFER, K.—**Ueber einige mikroskopisch-chemische Reactionen.** (On some micro-chemical reactions.)
[Tellurium. Selenium. Bismuth. Sulphates of Barium and Strontium. Sulphate and Chloride of Lead.]
SB. K. Bayr. Akad. Wiss. München, 1886, pp. 70–83.

HEINRICHER, E.—**Verwendbarkeit des Eau de Javelle zum Nachweis kleinster Stärkemengen.** (Use of Eau de Javelle for demonstrating small quantities of starch.) [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 213–5.

Heurck's (H. van) Method of Silvering Diatoms. [*Supra*, p. 900.]
Engl. Mech., XIII. (1886) pp. 548–9, from *Brit. Journ. of Phot.*

[HITCHCOCK, R.]—**Detection of Fats in Butter.** [*Post.*]
Amer. Mon. Micr. Journ., VII. (1886) pp. 135–7.

„ „ **On Mounting certain Diatoms.** [*Post.*] *Ibid.*, pp. 148–9.

HUBER, K., and BECKER, A.—**Die Pathologisch-Histologischen und Bacteriologischen Untersuchungs-Methoden mit einer Darstellung der wichtigsten Bacterien.** (The pathologico-histological, and bacteriological methods of investigation, with figures of the most important Bacteria.)
viii. and 122 pp., 13 figs., and 2 pls. (8vo, Leipzig, 1886).

Koch, R.—**Method of Staining Tubercle Bacilli.** Translated by *B. Pursh* (*comcld.*).
Micr. Bull. (*Queen's*), III. (1886) pp. 25–6, from *M T. K. Gesundheitsamte*, II.

KRAUSE, W.—**Untersuchungsmethoden.** (Methods of investigation.)
[Recommends a 10 per cent. aqueous solution of chloral hydrate for the retina instead of osmic acid—5 per cent. ammonium molybdenate—Zinc chloride for hardening brain according to Raltoni—The way to produce Watney's red and blue hæmatoxylin stains, and the different ways in which they may be applied—Martinotti's double stain with hæmatoxylin and eosin—Weigert's method with ferridcyanide of potassium.]
Internat. Monatsschr. f. Anat. u. Histol., I. (1884) pp. 152–7.

LIST, J. H.—**Beiträge zur Mikroskopischen Technik. II. Zur Verwendung der Javelle'schen Lauge.** (Contribution to microscopical technique. II. On the use of Eau de Javelle.) [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) p. 212.

LONG, J. H.—**On the Microscopic Examination of Butter.** [*Post.*]
Bull. Illinois State Micr. Soc., May 14th, 1886, 5 pp. and 1 pl.

MANTON, W. P.—**What to work with.**
["It is often a matter of question with the beginner, what objects shall be examined with the Microscope. The answer, roughly speaking, would be, *Everything.*"]
The Microscope, VI. (1886) pp. 161–3.

MINOT, C. S.—**A Staining-Dish.**
[A convenient form of staining-dish has hitherto been a desideratum. The new dish is made of clear glass with polished surfaces, and is sufficiently deep to hold a considerable quantity of fluid, while the curves inside are such that, although large sections lie nearly flat, yet when little fluid is used it gathers into the centre. The dishes, owing to their vertical sides, are readily stacked, while the bevel is wide enough for a label, which can be easily seen both when the dishes are stacked and as they are set upon the table singly.]
Amer. Natural., XX. (1886) pp. 675–6 (1 fig.).

MINOT, C. S.—**Notes on Histological Technique.** [*Post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 173–8.

MOLISCH, H.—**Berichtigung.** (A correction.)
[Dr. A. Ihl (see this Journal, V., 1885, p. 897) claimed to have found that in addition to the phlorglucin, specially made by Wiesner, other phenols stain wood-fibre in a characteristic manner, and Dr. Molisch remarks that Wiesner in 1878 called attention to the fact.]
Zeitschr. f. Wiss. Mikr., II. (1885) p. 359.

MORLAND, H.—**On Diatom Structure.**
[Contains directions for making very thin sections of "Cementstein," and separating and isolating the diatom sections. See also *post.*]
Journ. Quek. Micr. Club, II. (1886) pp. 297–307, 338–9.

NÖRNER, C.—**Zur Behandlung mikroskopischer Präparate.** (On the treatment of microscopical preparations.)
[Contains a variety of recommendations for hardening, staining, mounting, &c., including a description and figure of a lifter for removing sections from various fluids, consisting of a handle terminated at each end by a blade of German silver; the larger of these blades is triangular, and the smaller oblong and quadrangular.]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 19–23 (1 fig.).

OBERZUT, A.—**Prof. Spina's neue Färbungs-methode der Faülnissorganismen und ihre Beziehung zu den Tuberkelbacillen.** (Prof. Spina's new staining method for schizomycetes, and its relation to tubercle bacilli.) [*Post.*]
Deutsch. Med. Woch., 1885, No. 12.

PINCKNEY, E.—**Making Cells.**
[Wax cells covered with King's amber cement. Brass ring cells secured with same cement.]
Amer. Mon. Micr. Journ., VII. (1886) p. 152.

[QUEEN, J. W.]—**The Whitney Section-Instrument Improved.** [*Post.*]
Micr. Bulletin (*Queen's*), III. (1886) p. 30 (1 fig.).

" " **Grip Cement.**
[Recommended for fastening the Peirce cells to glass slides, and uniting glass and metal, or two metal surfaces, wood, &c. Also as a protective finish for slides against oil used for immersion objectives, and as a cell cement in cases where oils are used as mounting media.]
Micr. Bulletin (*Queen's*), III. (1886) p. 32.

ROGERS, W. A.—**Sweating.**
["I *think* I have overcome absolutely the difficulty of sweating by a form of mounting, which is simply one ring fitting loosely to an inner ring fastened securely to the slide."]
Micr. Bulletin (*Queen's*), III. (1886) p. 32.

SCHÄLLIBAUM, H.—**Beiträge zur mikroskopischen Technik.** (Contributions to microscopical technique.)
[Improvements in the process of fixing sections on the slide for subsequent staining, *post.*]
Zeitschr. f. Wiss. Mikr., III. (1886) pp. 209–11.

Schiefferdecker, P.—**Ueber ein neues Mikrotom.** (On a new microtome.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, III. (1886) pp. 151–64 (4 figs.).

Schimper, A. F. W.—**Anleitung zur mikroskopischen Untersuchung der Nahrungs- und Genussmittel.** (Guide to the microscopical examination of provisions.) viii. and 140 pp., 79 figs. (8vo, Jena, 1886).

Simmons, W. J.—**A Method of using Bismarck Brown.**

[Carbolic acid, 15 minims; distilled water, 1/2 fluid oz.; dissolve. Add saturated solution of Bismarck brown 3/4 fluid dram; filter, and keep in a corked or stoppered phial. The carbolic acid must be the strongest crystallized, and must be diluted in the usual proportion of one part distilled water to twenty parts of the crystallized acid. This method is an adaptation of a solution of fuchsin recommended by Gradle, Bismarck brown taking the place of fuchsin. It is well adapted for bacilli and gives excellent results with cells both animal and vegetable. The epithelial cells from the mouth stain in three or four minutes, the nucleus being well brought out. Sections of leaves and stems take a red stain for the nucleus; the chlorophyll granules at first retain their green colour, producing a very nice effect with the 1/4 or 1/8 objectives.]

Sci.-Gossip, 1886, p. 186.

Smith, H. L.—**High-refractive Media.** [*Supra*, p. 901.]

Journ. New York Micr. Soc., II. (1886) pp. 75–7 and 80.

Smith, T.—**A few simple Methods for obtaining pure Cultures of Bacteria for Microscopical Examination.**

[Hay Bacillus. Isolation by gelatin plates. Sterilizing potato. Agar-agar, &c.]

Amer. Mon. Micr. Journ., VII. (1886) pp. 124–5.

Stowell, C. H.—**Studies in Histology.**

[Methods of examining: mucous white fibres, yellow elastic and adipose tissue, cartilage and pigment-cells.]

The Microscope, VI. (1886) pp. 150–5 (6 figs.).

Strasser, H.—**Ueber das Studium der Schnittserien und über die Hülfsmittel, welche die Reconstruction der zerlegten Form erleichtern.** (On the study of series of sections, and on the means of facilitating the reconstruction of the original form.) [*Post.*]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 179–95 (2 figs.).

Upton, C.—**Mounting Chalk Organisms.—Mounting Coccoliths from Chalk.**

Sci.-Gossip, 1886, p. 212.

Vorce, C. M.—**Wax as a Material for Microscopical Mounting.** [*Post.*]

Amer. Mon. Micr. Jour., VII. (1886) pp. 123–4.

„ „ **Detection of Fat in Butter.** [*Post.*]

Amer. Mon. Micr. Jour., VII. (1886) pp. 156–7.

Wilbur, C. L.—**Desmid Fishing.** [*Post.*]

The Microscope, VI. (1886) pp. 169–71.

Williams, C. F. W. T.—**Preparation of Epidermis. Mounting Pollen, &c.**

[Place the leaf in distilled water in a test-tube and boil. Remove the epidermis and place in equal parts methyl-spirit, glycerin, water; mix. After an hour or two mount in glycerin jelly. Mount pollen dry, or if too opaque use glycerin jelly. Mount sections of stems in glycerin jelly, first soaking in above solution. As a rule avoid damar or balsam in mounting botanical specimens.]

Sci.-Gossip, 1886, p. 113.

Witt, O. N.—**Untersuchungen über einige zur mikroskopischen Zwecken verwandte Harze.** (Investigations on some resins suitable for microscopical purposes.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, III. (1886) pp. 196–206.

Woodward, A. L.—**Remounting Balsamed Objects in Fluid.**

[Algæ with adhering diatoms remounted in a solution of salicylic acid in water. "Upon putting the mount under the Microscope it was found to have undergone a remarkable change. The alga stood out sharply defined, and with all its structural details visible."]

Scientif. Enquirer, I. (1886) pp. 124–5.

PROCEEDINGS OF THE SOCIETY.

The first Conversazione of the Session was held on the 25th November, 1885.

The following objects, &c., were exhibited :—

Mr. J. Badcock :

Clathrulina elegans.

Mr. C. Baker :

Microscopes (fitted with Abbe condensers), and Oil-immersion Objectives by Zeiss. Micro-photographic apparatus by Seibert and Zeiss. Lamp with improved dark-chamber chimney. Anatomical and Bacteria preparations by Continental preparers.

Dr. J. W. Barrett :

Microtome for cutting sections of large objects, eyes, &c.

Messrs. R. and J. Beck :

Hymenophyllum crispatum, *Lygodium radicifolium*, and *Polypodium caudatum*, showing fructification.

Mr. T. Bolton :

Desmids from Sutton Park, *Amœbæ* and *Actinophrys*.

Mr. A. C. Cole :

Digestive glands of Pitcher-plant (*Nepenthes*).

Mr. Crisp :

D'Arsonval's Water Microscope.

Dr. E. M. Crookshank :

Preparations of Bacteria, and a large collection of apparatus for cultivating Bacteria and preparing media.

Mr. F. Enock :

Head of Wasp (*Vespa vulgaris*), showing upper and under side and the entire organs of the mouth and head. Oak-apple Fly (*Andricus terminalis*), showing muscular structures.

Mr. F. Fitch :

Humble Bee—part of intestine laid open and showing blind processes—stained.

Mr. J. D. Hardy :

Improved Tank for showing Pond Life. Cuthbert-Amici Reflecting Microscope, 1827.

Mr. W. Joshua :

Arthrosiphon alatus Grev. (Niagara Falls). *Bulbochæte crassiuscula* Nordst. (Kerris Moor, Penzance). *Volvox minor* Stein (Kerris Moor, Penzance).

Mr. G. C. Karop :

Testicle of Rabbit, developing spermatozoa.

Mr. A. Koerber :

Jablochkoff's new Dry Battery and Photophore.

Messrs. Laing, Wharton, and Down:
Electric Microscope Lamp with adjustable stand. Primary Battery capable of maintaining light (5 candles) for over six hours, and Secondary Battery capable of maintaining light for over 100 hours.
Mr. J. Mayall, jun.:
Barton's Buttons and Iris Ornaments, shown with electric lamp.
Mr. A. D. Michael:
The newly discovered Nymph of *Tegeocranus cepheiformis*.
Mr. E. M. Nelson:
Navicula californica, *N. Lyra* var., and *Arachnoidiscus* (1/6 in. objective, dark-ground with binocular).
Messrs. Powell and Lealand:
Amphipleura pellucida with 1/12 in. oil-immersion 1·5 N.A. and oil-immersion condenser: illuminated with the electric light as arranged by Laing, Wharton, and Down.
Mr. B. W. Priest:
Japanese Sponge (*Farrea occa*), showing veil of spicules.
Mr. G. J. Smith:
Limestone with diatoms (Isle of Moss, Jutland). Dolerite (Upsala, Sweden). Syenite. Diorite? (Hodries, Hungary).
Mr. J. H. Steward:
Spicules of *Gorgonia*. Head of Plumed Gnat. Fructification of Fern.
Prof. C. Stewart:
Stridulating Organ of Crawfish, *Palinurus vulgaris*, and of *Sphærotherium*.
Dr. J. T. Thompson:
Microscopical Drawings from Pathological Specimens.
Mr. A. Topping:
Section of Head of Lamprey, double-stained. Web of Foot of Frog, injected.
Mr. W. B. Turner:
Sea-spider (*Pycnogonium littorale* ♂).
Messrs. W. Watson and Sons:
Camera or Lantern Microscope. New Type Slide of 100 Diatoms. Arranged Slide of Diatoms, *Chirodota*, *Synapta*, &c., and Type Slide of 50 *Foraminifera*. Crystals of Brucin. Jaw of Kitten, showing displacement of temporary and development of permanent teeth. Grape-vine Blight (*Phylloxera*).
Mr. B. B. Woodward:
Longitudinal section of *Cerithium rugosum* Wood.

The second Conversazione of the Session was held on the 5th May, 1886.

The following Objects, &c., were exhibited:—

Mr. C. D. Ahrens:
New Polarizing Prism.
Mr. J. Badcock:
Stephanoceros, *Stentor*, and *Plumatella*.

Mr. C. Baker:
Bacteriological Microscopes. Students' Microscopes fitted with the Rev. J. A. Campbell's new differential screw fine-adjustment. New Microscope Lamp with dark-chamber chimney. Abbe Condensers modified for use with Students' Microscopes. Test Diatoms in zinc-chlorin by Möller. Marine Objects from Zoological Station, Naples.

Prof. F. Jeffrey Bell:
Philodina roseola dried in patches upon paper.

Mr. T. Bolton:
Young Eel.

Dr. F. Bossey:
Synedra lævigata.

Mr. E. Bostock:
Cryptognathus lagena (Kramer). *Sejus echinatus.*

Mr. F. R. Cheshire:
Living Spermatozoa from male *Apis mellifica*. *Bacillus alvei* in sporulation.

Mr. A. C. Cole:
Series of slides of Diatoms mounted in cassia oil.

Mr. Crisp:
1/8 in. oil-immersion objective (N.A. 1·40), by Zeiss, made of the new glass.

Dr. Crookshank:
Series of Photo-micrographs of Bacteria.

Mr. T. Curties:
Collection of Mouth-organs of Insects, dissected and arranged by Mr. Tatem.

Mr. F. Enock:
Heads of British Wild Bees: (Acutilingues) *Sphecodes, Halictus, Andrena, Cilissa, Dasypoda, Macropis.* (Obtusilingues) *Colletes, Prosopis.*

Mrs. Farquharson:
Spicules of fresh-water Sponge. Fern-spores.

Mr. F. Fitch:
Upper surface of Tongue of Hornet showing papillæ. Ditto of Wasp. Lung of Spider showing laminated structure. Silk-glands of ditto with ducts.

Mr. H. F. Hailes:
Foraminifera from King George's Sound.

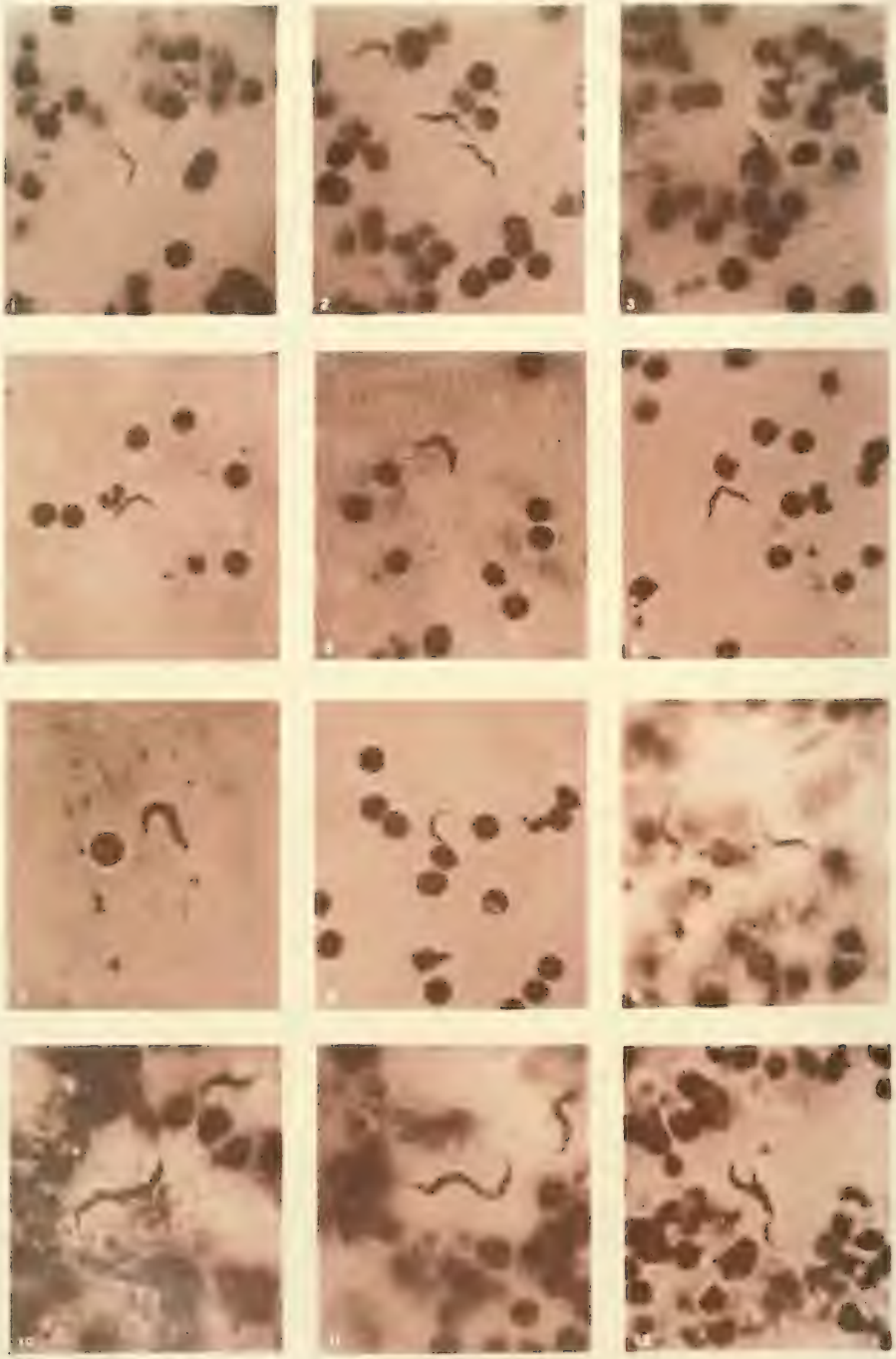
Mr. J. D. Hardy:
Model of a Diatom (*Surirella bifrons*) in clay from the life.

Mr. J. E. Ingpen:
Diatoms mounted in Sulphide of Arsenic, prepared by Mr. W. C. Meates.

Mr. W. Joshua:
Macrospores of Rhizocarps in Shale from Chicago river. *Achlya prolifera* with oogonium and ripe spores, from Reigate Heath.

Mr. G. H. King:
Daphnia.

Mr. A. D. Michael:
Salivary glands of a Dipterous Insect in situ.
Mr. E. M. Nelson:
Tubercle Bacillus (dry 1/6 in. on dark ground).
Mr. J. M. Offord:
Photo-micrographs of Diatoms (Platinotype).
Messrs. Powell and Lealand:
Amphipleura pellucida with 1/8 in. oil-immersion 1·29 N.A., and achromatic oil-immersion condenser 1·3 N.A.
Mr. B. W. Priest:
Fossil Sponge-spicules. *Spongilla iglooiformis* (Potts).
Mr. T. B. Rosseter:
Nematode from stomach of *Triton cristatus*. *Filariæ* found in body-cavity of *Cypris*. *Stephanoceros Eichhornii*.
Mr. G. Smith:
Basalt with Olivine, Schemnitz, Hungary. Tasmanite. Fossil Palm, Antigua. Clastic Rocks with Nummulites, Eisenbach, Hungary.
Prof. Stewart:
Ear-openings in leg of large green Grasshopper, and Nerve terminal organ.
Mr. A. Topping:
Series of Transparent Injected Preparations.
Mr. J. J. Vezey:
Section of Cuprea bark and Seed of Nux vomica.
Mr. C. M. Vorce:
Mud from Salt Lake containing eggs of *Artemia*.
Mr. J. G. Waller:
Desmacidon rostalis. Rare British Sponge.
Rev. A. G. Warner:
Crystalline or fungoid growth in diatom slide (Möller).



E.M.C. Photo. Autotype.

The "Surra" Parasite.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1886.

TRANSACTIONS OF THE SOCIETY.

XIII.—*Flagellated Protozoa in the Blood of Diseased and apparently Healthy Animals.*

By Edgar M. Crookshank, M.B. Lond., F.R.M.S.

(*Read 10th November*, 1886.)

Plate XVII.

In the year 1880 Dr. Evans presented a Report * to the Indian Government on a fatal disease, known by the natives as *Surra*, occurring in horses, mules, and camels. The importance of this disease may be realized from the fact that the 3rd Punjab Cavalry alone lost no less than 300 horses from it.

The malady was described as a blood disease, characterized by fever accompanied by jaundice, petechiæ of mucous membranes, great prostration, and rapid wasting terminating in death. The average duration of the disease was estimated at two months. No organic lesions were found after death, but *a parasite was discovered by Evans in the blood during life.* By means of subcutaneous inoculation and by the introduction into the stomach of blood containing the parasites, the disease was transmitted to healthy animals.

EXPLANATION OF PLATE XVII. PHOTOMICROGRAPHS OF THE "SURRA" PARASITE. (× 600.)

Taken on isochromatic plates, with Zeiss's 1/18 Hom. Imm. without eye-piece from a preparation stained with magenta. Photos 1, 2, 3, show the general form of the organism; 4, 5, 6, the undulating membrane on the upper edge; 7, the organism distorted and truncated at one end; 8, attached to a blood-corpuscle; 9, doubled over, the membrane appearing on the lower edge; 10, 11, two; and 12, three organisms fused by their non-flagellated ends.

* Report published by the Punjab Government Military Department, No. 439, 1880.

The disease was not observed to be contagious or infectious in the ordinary sense, but the possibility of its conveyance by means of large brown flies was suggested. These flies attack the horses so vehemently that the blood frequently streams from the bites; and the opinion that they propagated the disease was prevalent among the natives. At the same time it was particularly noted that at the outposts where the disease originated the water was very impure.

Evans discovered the parasite in all the diseased horses and mules examined, in all diseased camels with one exception, and in the dogs which had been subjected to experimental inoculations. The nature of this and similar parasites forms the subject of my paper.

Evans observes that when he first discovered the parasite he thought it was a spirillum, but very speedily on closer examination arrived at an opposite opinion.

To him the organism presented the appearance, when fresh and active, of an apparently round body, tapering in front to form a neck and terminating in a blunt head. Posteriorly he describes a tapering tail, from which there extended a long slender lash. At the head end there appeared in one or two cases a circlet of pseudopods, and as the body slowly died in serum it gave the appearance of flattening out. After watching very closely all its changes of form and movements Evans came to the conclusion that there existed on either side of the body two fin-like papillæ, one near where the neck began and the other close to where the tail began. In only very few instances, he adds, he was able to see the four at once. He suggested that these processes were of the nature of pseudopods.

The parasite he describes as extremely active in its movements, with an undulatory eel-like motion, progressing for the most part head-end foremost but occasionally moving in the direction of the lash when tugging at a corpuscle. In fresh blood these organisms resembled spermatozoa in colour, but their peculiar characteristic was the power they possessed of attacking and disintegrating the red corpuscles.

Occasionally two were observed to unite and swim off as one body, but the mode of union was a disputed point. Evans thought that they joined with their respective heads and tails in the same direction overlapping each other, but Dr. Hay, to whom they were shown, was of opinion that they fastened with their tails in opposite directions.

The parasites were not always present in the blood, but were observed to come and go in successive broods. Evans referred the organism to the late Dr. Timothy Lewis for his opinion as to its nature. Lewis arrived at the conclusion that the parasite was "more nearly related to that which he found in the blood of rats

than to any other," but he was of opinion at the time that they did not appear exactly the same.

Five years later Surra broke out in British Burma. A Report * was issued by Veterinary Surgeon Steel who was deputed to investigate the outbreak. Steel confirmed the communicability of the disease to dogs, horses, and mules, by ingestion and inoculation, but he considerably supplemented Evans' views as to the nature of the disease by careful thermometric observations. These finally led him to regard the disease as a true relapsing fever, closely resembling relapsing fever in man; at the same time it is worth recording that until Steel observed the presence of the parasite described by Evans he regarded the outbreak as malarious in origin, and provisionally termed it gastric typhoid. In the Burma outbreak, as in the Punjab epidemic, considerable evidence was adduced in favour of regarding the disease as being due to bad water supply.

Steel succeeded in staining the organism with anilin dyes, but his description of the parasite in the fresh state differs very materially from that given by Evans.

Steel failed to recognize the round body tapering in front to a neck. To him the bodies appeared thick in the middle, gradually diminishing in size in either direction, with a blunt and rigid extremity at one end. The opposite end he described as tapering in such a way as to produce a subspiral prolongation which was uncurled and lashed about freely like a whip. This tail was described as slender in relation to the general size of the parasite, but under the highest power available, the presence of a colourless flagellum could not be detected, nor, he adds, did the movements of the blood-constituents indicate its existence.

Steel also failed to see the slightest sign of the two fin-like papillæ on each side as described by Evans, an opinion in which he was supported by Lewis.

These two observers, Evans and Steel, also differed as to whether the movement be called spiral. Steel felt convinced that their movement was as much of that nature at times as can be expected from organisms with so open a corkscrew shape, while Evans maintained an opposite view. In the dried and stained specimens Steel observed that they retained their subspiral form of body and markedly spiral form of tail.

Steel found that the disease could be communicated to the dog and to the monkey, and then discussed the resemblance of the parasite to the spirillum of relapsing fever in man.

From the different appearances presented by the parasite when in the living state and when dried and stained, Steel thought that there was probably a still closer resemblance to the living spirillum

* Veterinary Surgeon J. A. Steel, A.V.D., 'An Investigation into an obscure and fatal Disease among transport mules in British Burma, 1885.'

than to the dried and stained one, and argued that the figures of spirilla like huge corkscrews must be purely imaginary, being deduced from ideas of what the parasite in motion would be like if it were sufficiently enlarged. Steel, it must be observed, founded these remarks upon figures in text-books and not on photographs, or on a practical acquaintance with the spirillum of relapsing fever. One cannot refrain from pointing out the value of photomicrographs, for they cannot be called into question, and had Steel studied photographs of spirilla he would not have regarded the corkscrew appearance as imaginary.

Steel found the parasite in all cases, and further observed that it appeared as the temperature rose and disappeared during the apyrexial periods.

From all these observations Steel concluded as follows:—That relapsing fever of mules is an invariably fatal disorder, characterized by the periodical occurrence of attacks of high fever, during which a special organism closely resembling the spirillum of relapsing fever in man is found in the blood. This organism is one-sixth the size of a red corpuscle in width and three to six times in length. It is eel-like, and when dried and stained presents a thick portion, the body, and a spiral tail. The latter takes less of the dye than the former and commences as a sudden narrowing of the body, terminating by a fine point. This he insisted had nothing of the nature of an infusorian flagellum. The thick portion tapers in either direction from its centre, and terminates in front abruptly in a rigid process with probably some holdfast organ. The sharpness of the head-end varies in different animals. The body portion he described as spiral, as is compatible with its diameter, and so closely in general appearances to resemble the spirillum of relapsing fever as figured by Ziegler, that he concluded that the organism was undoubtedly a spiral bacterium and named it after its discoverer *Spirochæta Evansi*. This view, however, would not be accepted by Evans, who maintained that whatever it might be, it was not a member of the family of bacteria.

In the face of these conflicting opinions Dr. Evans was good enough to place in my hands for investigation some preparations of the organism in the blood as well as material from the lungs and intestines of a camel that had succumbed to the disease.

On examining a stained preparation I found that with a power of 200 diameters a number of the parasites could be distinguished in the field of the Microscope, and with 1/12 and 1/18 O.I. objectives the individual characteristics were clearly brought out. These were quite sufficient at once to dispel the idea of its being a spirillum. It was obvious that it was a more highly organized micro-parasite, presenting very peculiar and distinctive structural appearances.

The *first glance* at the parasites recalled the appearance of nematode hæmatozoa, as if, indeed, they might be embryo *Filariæ*, but when I had carefully studied several specimens, and had further undergone the searching examination entailed by the accurate focusing necessary to obtain a number of sharply-defined photomicrographs, I came to the following conclusions:—

The somewhat tapering central portion, or body, of the parasite is continuous at one end with a whip-like lash, and at the other end terminates in an acutely-pointed stiff filament or spine-like process. Here and there, possibly from injury or want of development, the spine-like process appears to be blunted or absent (Photo 7). By very careful focusing on the upper edge of the central portion, I discovered the existence, much more markedly in some of the parasites than in others, of *a longitudinal membrane* with either a straight or undulating margin (Photos 4, 5, 6, and fig. 193). The membrane is attached along the body, arising from the base of the rigid filament, and becomes directly continuous at the opposite end with the flagellum. In some cases the edge only is deeply stained, giving the appearance *of a thread continuous with the flagellum*, so that one might be easily led to overlook the membrane, and imagine that the flagellum arose from the opposite end of the body, at the base of the spine-like process.

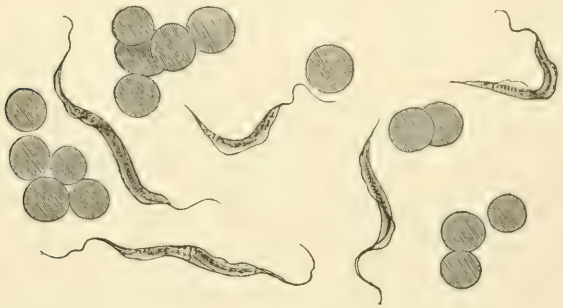
Close to the base of the spine-like process a clear unstained spot is, in many parasites, easily distinguished (Photos 1, 2, 3), and at the opposite end there is, in some, the appearance of the deeply-stained protoplasmic contents having contracted within the faintly stained membranous investment. Where the longitudinal membrane has a wavy outline the undulations are much more marked in some cases than in others. Here and there the wavy outline appears first on the one side of the central portion, and then on the other, but there never is any waving outline on both sides of the same part of the body, and this was explained by careful examination, which showed that in dying the somewhat ribbon-like parasite had become doubled on itself (Photo 9). The discovery of this undulating membrane at once suggested to my mind an explanation of the lateral pseudopodia described by Evans. If we imagine that we are looking down upon the parasite, with the edge of the membrane towards us, one can conceive that the rapid undulations first on one side and then on another, might give an image upon the retina which could be construed as due to the protrusion of lateral pseudopodia. I may add that I could not discover in the stained preparations any trace of the circlet of pseudopods, and I think the undulating membrane may account for this appearance also.

Owing to the somewhat curved and twisted shape of the

parasite and the curling of the flagellum, in the stained preparations, it was difficult to make exact measurements, but I was able to ascertain that the average width, according to whether the membrane was visible or not, varied from 1 to 2 μ and the length of the body from 20 to 30 μ. The flagellum was about the same length as the body.

Here and there in a stained preparation there were the forms already described by Evans resulting from the fusion of two parasites. But the union obviously took place by the non-flagellated ends, for the two flagella were frequently turned in the same direction, so that the fused parasites resembled, as Dr. Evans subsequently suggested, a trophy of buffalo horns (Photo 11). Here and there more than two parasites had united, forming a stellate group (Photo 12), and in one case I noticed that the individuals had apparently united with their non-flagellated ends just overlapping, so that the unstained spot in one was just situated in a line with the unstained spot of the other (fig. 193).

Fig. 193.



"Surra" parasites occurring singly and fused.
From preparations stained with magenta × 1200. (Lent by Dr. Evans.)

I have already mentioned that in Evans's Report Lewis's opinion is given that these parasites differed slightly, but still were closely allied to certain flagellated organisms which had been observed by him in rats in India. On referring to his original memoir * I found that *his description* and *woodcut* differed very materially from the Surra parasite *as just described*, though a photomicrograph which Lewis had appended to the memoir after it was written indicated a great similarity to this organism. To me, the organisms appeared not only closely allied, but as far as one can judge from figures and descriptions, morphologically identical with the parasites

* 'Microscopic Organisms in the Blood of Man and Animals,' Calcutta, 1879 (with photo); and Quart. Journ. Micr. Sci., lxxiii. (1879) pp. 109–14.

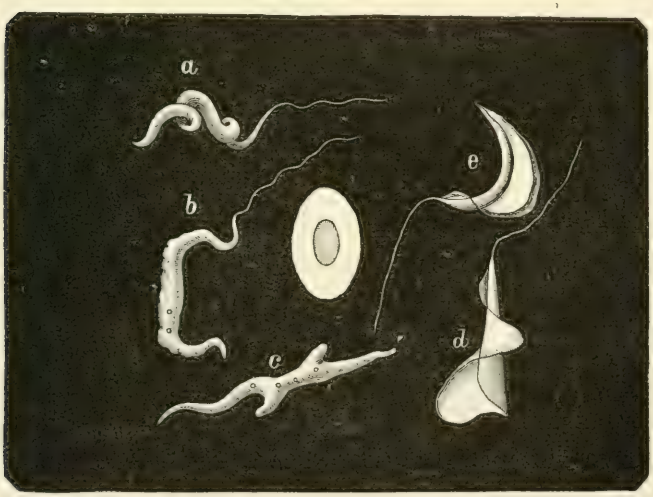
described by Mitrophanow in the carp. I shall refer again to the flagellated organisms first described by Lewis and show that his woodcut and descriptions were not complete, and in some points open to doubt, and that as a matter of fact, instead of a mere resemblance, the rat and the Surra parasites, when stained, are found to be morphologically identical.

In a subsequent paper * Lewis acknowledges this identity after further observations on the living organisms, though he still failed to recognize the two remarkable characteristics, the posterior spine-like process, and the longitudinal membrane.

In the year 1883 Mitrophanow published a paper † in which he gave an account of organisms in the blood of the mud-fish and the carp.

In the blood of the mud-fish (*Cobitis fossilis*) the organisms at the first glance looked like minute nematodes, but the appearances

Fig. 194.



Organisms in the blood of Mud-fish (*Hæmatomonas cobitis*).
a, First variety; *b*, second variety; *c*, third variety.
d, First variety in a state of diminished activity.
e, The same after treatment with osmic acid. (After Mitrophanow.)

and changes which took place on further examination showed nothing in common with worms (fig. 194). As a 1 per cent. salt solution had been added to the blood under examination, it occurred

* "Further observations on Flagellated Organisms in the Blood of Animals," Quart. Journ. Micr. Sci., xxiv. (1884) pp. 357–69.

† "Beiträge zur Kenntniss der Hämatozoen," Biol. Centralbl., iii. (1883) pp. 35–44.

to Mitrophanow that they were possibly the cytozoa described by Gaule;* but this idea was dismissed, by the fact that they were found in blood to which no salt solution was added. Their size varied from 30 to 40 μ in length and 1 to 1½ μ in width. At first their rapid movements baffled examination, but as the rapidity lessened there was the appearance of a curling movement in the body portion and a swinging movement of the lash. The organism moved in the direction of the lash, the anterior end of the body being more pointed than the posterior, and gradually fining off into the lash. When the body seemed to rest, the lash might be seen to whip out in all directions. As the movement of the body gradually diminished, it appeared to have a complicated screw form, the axis of the screw corresponding to the body to which an undulating membrane is fastened spirally. This could be distinguished when the organism was dying, because the body in death contracted, and the membrane then looked like a spiral addition. Thus the organism consisted of a body, a spiral membrane, and a flagellum.

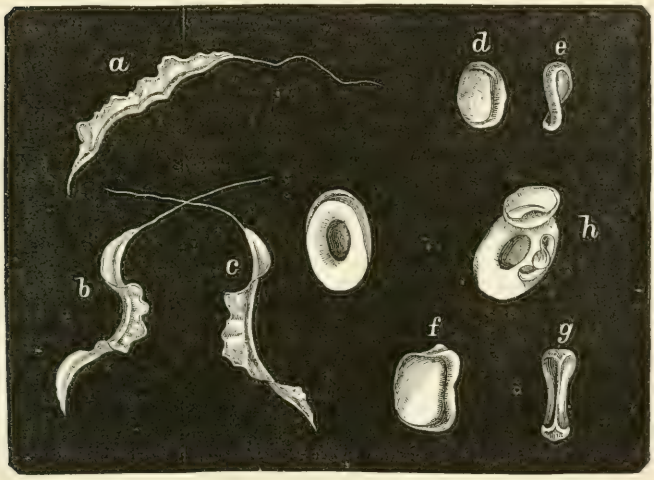
With higher magnification the organism appeared to consist of a refractive, strongly contractile protoplasmic substance, which, when death occurred, formed a shapeless mass. In the same blood two other forms were observed, one without a membrane, but having two highly refractive spherules in the protoplasm, and another with neither membrane nor flagellum, consisting of very granular protoplasm with several refractive spherules, and capable of protruding processes like pseudopodia.

In the carp (fig. 195) the parasite is perceptibly larger, and possesses an undulating membrane fastened along the edge of the long body. When the body bent first towards one side and then to the other, a wave-like movement was observable at the free edge of this membrane.

* In 1871 Prof. Lankester (Quart. Journ. Micr. Sci., xi. pp. 387–9) described an organism which he had discovered in the blood of the frog (*Rana esculenta*). It consisted of a minute pyriform sac with the narrower end bent round on itself somewhat spirally, and the broader end spread out into a thin membrane, which exhibited four or five folds and was prolonged on one side into a very long flagellum. The wall of the sac was striated, nucleated, and granular; the membrane undulated during life, and the flagellum was also motile. It was named *Undulina ranarum*, but subsequently recognized as identical with *Trypanosoma sanguinis* described by Gruby (Comptes Rendus, Nov. 1843). In the same blood Lankester also discovered little oblong bodies, in many cases attached to the end of the red corpuscles, and suggested a genetical connection with the Undulina. One or more motionless filaments were occasionally observed attached to these bodies. Gaule ("Ueber Würmchen welche aus den Froschblutkörperchen auswandern," Archiv. f. Anat. und Physiol., 1880, s. 57) subsequently observed the same bodies, and regarded them as resulting from the metamorphosis of the cells of the frog's blood. Gaule's observations were refuted by Lankester in 1882 (Quart. Journ. Micr. Sci., xxii. pp. 53–65), the parasitic nature insisted upon, and the organism named *Drepanidium ranarum*. Lankester suggested that they were probably the young stage of a sporozoon allied to the *Sarcocystis* or to *Coccidium*.

These parasites were found in all the mud-fish examined except one, and in greater numbers in the hot months. In the carp they were only found occasionally. Mitrophanow described other varieties, which he considered were possibly not complete organisms

Fig. 195.



Organisms in the blood of the carp.
a, *b*, *c*, *Hæmatomonas carassii*. *d*, *e*, *f*, *g*, *h*, other organisms in the same blood.
(After Mitrophanow.)

but developmental forms. He considered that these organisms were infusoria between the genera *Cercomonas* and *Trichomonas*, with great similarity to the *Trichomonas* described in the Lieberkuhn's glands of fowls and ducks [Eberth *].

On account of their special habitat, Mitrophanow suggested a new genus—*Hæmatomonas*, defining this genus as follows:—Parasites of normal fish-blood, worm-like, actively moving organisms, with indistinct differentiation of body parenchyma. Bodies pointed at both ends, 30 to 40 μ long and 1 to 1½ μ wide. May possess in front a flagellum, and on one side an undulating membrane.

Species:—

Hæmatomonas cobitis.—Body provided with a spiral membrane and a flagellum at the fore-end. Parenchyma of body homogeneous. Second variety, body and flagellum only. Movement undulatory, body containing highly refractive spherules. Third variety, plasma-like body, without membrane or flagellum; quickly

* *Vide* Leuckart, 'The Parasites of Man,' translated by Hoyle, p. 248.

changes form by sending out processes laterally, and contains two to four refractive spherules. Blood of mud-fish.

Hæmatomonas carassii.—Long bodies, with narrow membrane attached along the whole length; less actively motile. Several forms also observed strikingly smaller than the above; many disc-shaped. Often seen attached to a red corpuscle, setting them in motion by their movements. Blood of carp.

From my observations of the Surra parasite (especially the discovery of the undulating longitudinal membrane) I recognized a very close resemblance to Mitrophanow's descriptions, and concluded that if we followed the classification adopted by Mitrophanow his genus of *Hæmatomonas* must not be restricted to organisms in fish-blood. It must be expanded to include this parasite of mammalian blood, which should in that case be named *Hæmatomonas Evansi* rather than *Spirochæta Evansi* as proposed by Steel.

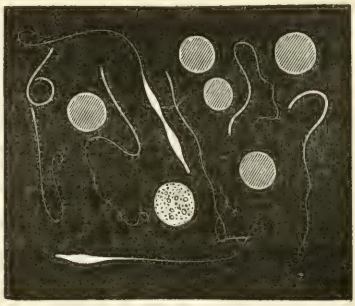
I now revert again to the flagellated organisms observed by Lewis. The different impression conveyed to me by his photographs on the one hand and his woodcuts on the other, led me to desire to investigate this organism for myself; and moreover it promised to afford me a new object for work I had recently brought before the Society, namely, the photography of flagella. In speaking of these organisms, Lewis remarked that it was strange that they had not occupied attention before, and suggested as an explanation that possibly European rats did not harbour these parasites. My first thought was to obtain some rats from India, but it occurred to me it would be interesting to make sure that these parasites were not found in Europe. I therefore examined a few white rats without success and then proceeded to examine the blood of common brown rats, and in some, to my astonishment, I found that it teemed with exceedingly active organisms. I immediately obtained a large number of brown rats trapped from the London sewers, and I have ascertained that these organisms are *to be found in no less than* 25 *per cent. of apparently healthy animals.* The first question which naturally arose was whether these organisms in European rats were identical with those described by Lewis in Indian rats.

If we refer to the description given by Lewis, we find that he states that when he first noticed them he thought they were vibrios or spirilla. The drop of blood under examination appeared to quiver with life, and on diluting the blood, motile filaments could be seen rushing through the serum and tossing the blood-corpuscles about in all directions.

The filaments were pale and translucent, *without any trace of visible structure or granularity,* and they were more undulatory in movement than spirilla. A corpuscle might be observed to quiver,

and this could be distinctly traced to be due to the existence of a flagellum, *apparently a posterior flagellum*,* as the organisms seemed generally to move with the thicker end forward; no flagellum could be detected at the opposite end. The greater number of the figures in the woodcut (fig. 196) are described as representing these organisms a few hours after the blood had been obtained, when their movements are not so rapid, and the flagellum becomes more recognizable.

Fig. 196.



Parasites in the blood of rats (after Lewis).

On careful examination the plasma which constituted the thicker portion of their substance was observed to suddenly swell out so as to divide the body into two parts, as seen in the centre of the figure; at other times two or three such constrictions or dilatations were detected, and at other times the body assumed an arrow shape, as depicted at the lower part of the figure. When dried, and stained with a little weak solution of anilin-blue, the body presented a very different appearance. It was found to have contracted irregularly, and to manifest a somewhat granular and shreddy appearance, suggestive of a coagulated fibro-albuminous substance. The body portion became flattened towards its middle to double its original width, and both ends almost acutely pointed, while the flagellum was only partly visible. After fixing with osmic acid they measured 0·8–1 μ in width, and 20–30 μ in length; the flagellum was about as long as the body, so that the total length of the organism was about 50 μ. Lewis detected these parasites in 29 per cent. of the species *Mus decumanus* and *Mus rufescens*, but failed to find them in mice. He considered that they had many features in common with motile organisms of vegetable origin, but they appeared to approach much more closely to the Protozoa, more particularly several of the species of Dujardin's *Cercomonas*. He points out that many, however, believe that these organisms are

* This observation led Kent, who named the organism *Herpetomonas Lewisi* ('A Manual of Infusoria,' p. 245), to remark that if, as Lewis is inclined to maintain, that organ "propels instead of draws the animalcule through the inhabited serum we have presented a structural and functional feature without parallel among the other representatives of these *Protozoa flagellata*, the recognition of which would demand the creation of a distinct generic and family group for the reception of these singular organisms." In his later paper, however, Lewis came to the conclusion that like the generality of flagellated organisms, the rat parasites moved with the lash in front.

zoospores and not animalcules. To him they also seemed to be not unlike the flagellated parasite described by Bütschli.*

The latter observer, I find, detected flagellated organisms (*Leptomonas* † *Bütschlii*) in the intestinal canal of a free nematode (*Trilobus gracilis*). They too form stellate colonies, as I have photographed from a stained preparation of the Surra parasite, owing to their being attached by their non-flagellated ends. When detached from these colonies they presented a somewhat spindle-shaped body about 11 μ in length, with a somewhat thick flagellum about double this in length, so that the total length of the protozoon would be 33 μ, or as Lewis states, about half the length of the flagellated organism in the rat's blood. Near the base of the flagellum Bütschli's protozoon presented a contractile vacuole, but Lewis was unable to detect any such vacuole in the rat hæmatozoa.

In conclusion Lewis observed that, very probably, these organisms corresponded with the vermicules observed by Dr. Goss in the blood of a field mouse, and he also mentions that M. Chaussat found minute nematodes in the blood of a black rat.

Before passing on to compare my observations with those of Lewis, I may here state that in the autumn of 1879, Wittich ‡ discovered in the blood of hamsters, whip-like bodies with lively movements. They resembled frog's spermatozoa, possessing a thick portion continued into a long lash-like thread. Wittich considered them identical with the organisms described by Lewis, and they also were observed in apparently healthy animals. Koch later § met with the same organisms.

I now pass on to describe my own observations upon the common brown rat in England. Like Lewis I found that the blood appeared to quiver with life, and that the parasites were extremely difficult to examine until their movement was arrested for a moment or they became imprisoned in the serum areas. After examining with various powers, from a 1/5 dry to a 1/25 oil-immersion of Powell and Lealand, I came to the following conclusions:—That they are polymorphic, presenting for the most part slightly tapering bodies which terminate at one end in a stiff, immotile, acutely-pointed flexible filament or spine-like process, and at the opposite end are provided with a long flagellum, while longitudinally attached a delicate undulating fin-like membrane can be traced, which starts from the base of the posterior filament, and becomes directly continuous with the flagellum (fig. 197).

* "Researches on the flagellated Infusoria and allied organisms," Zeitschr. f. Wiss. Zool., xxx, and Quart. Journ. Micr. Sci., lxxiii. pp. 63–103, pl. VI. fig. 5.

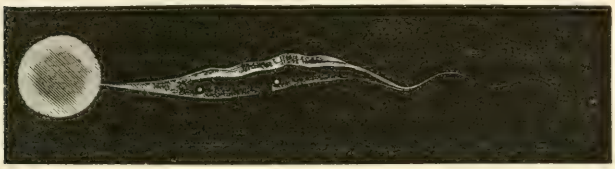
† Kent, 'A Manual of the Infusoria,' p. 243.

‡ "Spirillen im Blut von Hamstern," Centralbl. f. Med. Wiss., 1881, No. 4.

§ Mitteilungen aus der Kaiserlich. Gesundh., 1881, p. 8.

With careful illumination the body is found to be distinctly granular, with one or more highly-refractive spherules. When the rapid movement is arrested the undulating membrane is distinctly visible. The best opportunity occurs for seeing this when

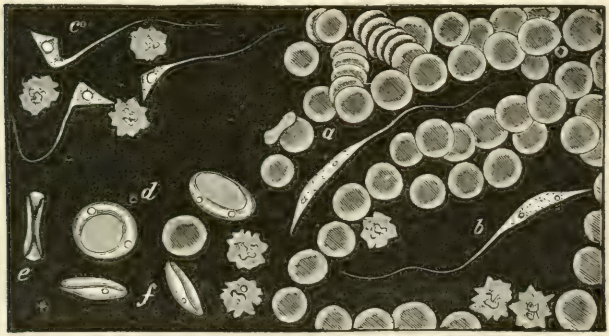
Fig. 197.



A monad in rat's blood. The organism is represented at partial rest with its posterior filament impinging on a corpuscle, and showing the undulating longitudinal membrane, the long flagellum, and the refractive spherules in the granular protoplasm (× 3000).

the organism comes to partial rest with its stiff filament against a corpuscle, as if to obtain a *point d'appui*, while lashing its flagellum in all directions (fig. 198, *b*). At other times, when the parasite

Fig. 198.



Monads in rat's blood × 1200. *a*, A monad threading its way among the blood-corpuscles; *b*, another with pendulum movement attached to a corpuscle; *c*, angular forms; *d*, encysted forms; *e* and *f*, the same seen edgeways.

has impinged with its posterior extremity against a corpuscle, or the stiff filament is apparently entangled in débris, the movements of the organism give one the idea of its endeavouring to set itself free, but I have not been able to persuade myself that they "attack and disintegrate" the red blood-corpuscles.

In the active state the thicker portion, or body, appears to twist and bend from side to side with great activity. The organism

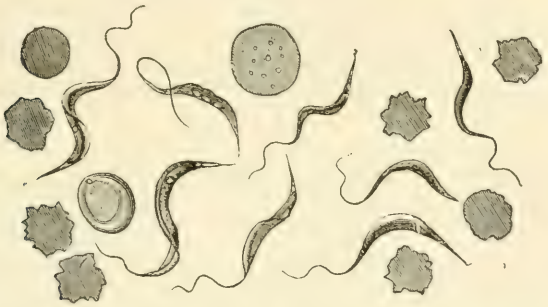
can turn completely round with lightning rapidity, so that the flagellum, at one moment lashing in one direction, is suddenly observed working in the opposite direction. Then suddenly the organism makes progression, and it can be distinctly seen *to move in the direction of the flagellum, the flagellum threading its way between the corpuscles and drawing the rest of the organism after it.* Currents set up by evaporation may undoubtedly here and there produce the appearance of the organism "wriggling along" with its flagellum posterior, but I am convinced in my own mind, after hours of patient observation, that in the normal mode of progression, the flagellum acts as a tractellum and not as a pulsellum. By treating cover-glass preparations with osmic acid the appearances obtained are very similar to what is shown in Lewis's photographs, so that I have no doubt, in spite of our descriptions not completely according, that they are one and the same organism. A great likeness to the organisms described by Mitrophanow, and to the Surra parasite described in the earlier part of this paper, at once occurred to my mind, and when I had stained the rat parasites the closest examination confirmed my belief that they were morphologically identical with the stained parasites of Surra.

I passed the cover-glasses with a thin layer of blood three times through the flame of a Bunsen burner in the way commonly employed for examining micro-organisms, and stained them with an aqueous solution of fuchsin, methyl-violet, and Bismarck brown. I have also stained them with aurantia, nigrosin, and other anilin dyes. The following method will however be found most instructive. Use freshly prepared saturated solution of fuchsin or methyl-violet in absolute alcohol, and put a drop with a pipette on the centre of the preparation; do not disturb the drop-form for a few moments; then, before the alcohol has evaporated, wash off the excess of stain. It will be found that where the drop rested the organisms will be very deeply stained, while in the surrounding area the colour will vary in intensity. By the effect of the different degrees of staining much may be learnt (fig. 199). In one organism the body and entire membrane will be equally stained; in another the margin of the membrane only. In some the posterior stiff filament is stained and at its base a darkly stained speck is very striking, and in other cases again the posterior filament is only faintly tinged, or an unstained spot occurs near its base.

The morphological identity of the rat and Surra parasites is thus established, and both seem morphologically identical with the organism of Mitrophanow. This leads me to speak of the classification of these organisms, for if we follow Mitrophanow, we must obviously enlarge his genus of *Hæmatomonas;* I venture, however, to disagree with Mitrophanow in the advisability of

adopting this entirely new generic name. Mitrophanow suggested this new term because of the special habitat, normal fish-blood, of the species he discovered. But the characteristic features of these organisms are the characteristic marks of the genus *Trichomonas.** It seems to me therefore that they are embraced by the

Fig. 199.



Monads in rat's blood stained with methyl-violet, showing membrane under different aspects, blood-corpuscles, some crenated, and stained discs (× 1200).

old genus *Trichomonas*, and that there is no need to create a new one, *Hæmatomonas*. The common habitat of these species may be expressed by grouping them together in one sub-genus, *Trichomonas sanguinis, but the question arises whether they are distinct species.* If it were not for the different description given by Mitrophanow of the organism in the mud-fish, I should be inclined to say that these organisms belonged to one and the same *species*, which might well be named *Trichomonas sanguinis.* I have shown that the monad in the rat and the Surra parasite are *morphologically* identical with each other, and both, as far as one can judge from the description, morphologically identical with the monad in the blood of the carp. We have, however, seen that the organism in Surra is believed to be pathogenic, and too much stress must not be laid on morphological identity. There is strong evidence in favour of believing in its pathogenic properties, but at the same time it must be borne in mind that the organism has never been *isolated apart from the blood,* and the disease then produced by its introduction into healthy animals. It is quite possible that the parasites in Surra are only associated with the disease, the impoverished blood affording a suitable nidus for their development, while the contaminated water may be the common source of the organism and of the disease. On the other hand, the organism in the rat is found in apparently perfectly healthy,

* Leuckart, 'The Parasites of Man,' trans. by Hoyle, 1886.

well-nourished animals. These points indicate many lines of inquiry, and I must reserve for a future communication the results of the examination of mud-fish, of keeping rats, known to harbour the parasite, under observation, and of testing the pathogenic influence of the organism on other animals. Provisionally I would suggest that the parasites observed in the rat and hamster should be named after Dr. Lewis, *Trichomonas Lewisi;* the organism in the mule, camel, and horse after its discoverer, *Trichomonas Evansi;* and that the names *Trichomonas cobitis* and *Trichomonas carassii* should be substituted for the names of the species described by Mitrophanow. Thus we should have added provisionally to the

Genus—Trichomonas.

Sub-genus—*Trichomonas sanguinis.* Definition: Elongated tapering bodies, provided with a spiral (*T. cobitis*), or longitudinal (*T. carassii, Lewisi, Evansi*) membrane, terminating in a rigid filament, and an anterior flagellum. Highly polymorphic. Habitat the blood.

Species.—*Trichomonas cobitis* (*Hæmatomonas cobitis* Mitrophanow)—Mud-fish.

Trichomonas carassii (*Hæmatomonas carassii* Mitrophanow)—Carp.

Trichomonas Lewisi (*Herpetomonas Lewisi* Kent)—Rat, hamster.

Trichomonas Evansi—(*Spirochæta Evansi* Steel)—Horse, mule, camel; (pathogenic?).

I have made several observations upon the life-history of these rat organisms, and have distinguished globose, angular, non-filamentous, bi-flagellate semi-circular, and disc forms. These elastic disc-like bodies (fig. 198, *d*), apparently the encysted stage, appear to be identical with certain bodies figured as associated forms by Mitrophanow, another point tending to confirm the identity of these organisms. These points also I must make the subject of another communication, having already exceeded the limits of a single paper.

Trichodina

West, Newman & Co lith.

XIV.—*On Trichodina as an Endoparasite.*

By T. B. Rosseter, F.R.M.S.

(*Read 13th October*, 1886.)

Plate XVIII.

I was led to the discovery of this Infusorian as an endoparasite by a fortunate accident. Being anxious to find the habitat of an endoparasite I had observed attached to the muscles of the larva of *Corethra plumicornis*, whose life-history I was working out, I selected the smooth water-newt as my subject, knowing from observation of its habits that the newt feeds largely on these and similar larvæ; but whilst dragging for them, I captured some specimens of *Triton cristatus*, which I therefore included in my investigations.

Previous to experimenting with the larvæ it was necessary to ascertain what parasitic life the newt gave shelter to in its alimentary canal, so that in tracing out the life-history of the endoparasite of which the larva of *Corethra* is the host, the metamorphoses of one parasite might not be confounded with those of another.

It was during the dissection of one of the newts so obtained that I observed in the fluid in which the viscera were placed, a species of *Trichodina*, resembling, but not, I think, identical with, *T. pediculus*, which is so frequently found as an ectoparasite on *Hydra vulgaris* in company with *Kerona polyporum*. The creature was so named by Ehrenberg, a name which it still retains with English naturalists, although it is known to Continental investigators under other names. Dujardin * places it as the second genus in his family of Urceolarieæ, naming it *Urceolaria stellina*, but all writers agree in the fact of its being *ectoparasitic* only, and free-swimming in its habits. Dujardin says, "La face opposée garnie d'une couronne complète de cils, au

EXPLANATION OF PLATE XVIII.

Fig. 1.—Male organs of newt (after Owen), showing habitat of *Trichodina*. *a*, testes. *c*, efferent tubes. *e*, kidney. *f*, urino-seminal canal. *g*, ureters.

Fig. 2.—*Trichodina* sp. lateral view × 500.

Fig. 3.— „ ventral view.

Figs. 4 and 5.—Showing articulation of acetabulum (fig. 4 lorica, fig. 5 acetabulum).

Fig. 6.—Illustrating action of picro-carmine on the living subject, showing lorica partially disintegrated, acetabulum detached, and ejected endoplasm.

Fig. 7.—*Trichodina* in situ on *Hydra* (Saville Kent).

* 'Histoire Naturelle des Zoophytes,' 1841, p. 527.

moyen desquels l'animal nage librement ou marche à la surface des Hydras." Saville Kent, in his 'Manual of the Infusoria,' p. 646, retains the name of *Trichodina pediculus*, and, under habitat, distinctly classes it as an ectoparasite, referring also to a new habitat, on the branchial appendages of larvæ of *Triton cristatus*. This I am able to confirm, having found them this year in the same place on larvæ of *Triton*. These *Trichodina*, which are ectoparasitic on the branchiæ of the larva of *Triton*, retain their affinity for *Hydra vulgaris*, as can be proved by taking some from a larva of *Triton* whose branchiæ are infested with them, and placing them in a watchglass with *Hydra*, when they will be seen to attach themselves by their acetabulum to the surface of the tentacles of the *Hydræ*.

I have searched carefully to discover if these *Trichodina* are ectoparasitic on either the adult triton or newt, but have been unsuccessful, although I have captured both in company with larvæ, whose branchiæ have been infested with them.

In order to trace the origin of the *Trichodina* which, as I have said, I found accidentally, I determined in March of the present year to investigate the matter systematically, and accordingly I killed a male specimen of *Triton cristatus* with chloroform, washed it with warm water with a camel's hair brush, opened it ventrally, and extracted the viscera. These were placed in a watchglass with distilled water, when numbers of *Trichodina* were observed with a 1 in. objective in the fluid; some were taken up with a pipette, placed on a glass plate, covered with a cover-glass, and carefully compared with the figures of *T. pediculus* in Saville Kent's 'Infusoria,' which they were found closely to resemble. A female *Triton* was next taken, and subjected to the same process, but proved a failure. A male smooth water-newt was treated in the same way, and yielded an abundant supply; but a female newt from the same source was barren of results. These preliminary observations furnished sufficient evidence that the *Trichodina* did exist in the viscera as endoparasites, and I may say that great caution was exercised in regard to the cleanliness of the troughs, pipettes, and dissecting instruments that were used.

On the 18th of June I captured some newts, and entered upon a still more thorough investigation of the subject.

A small newt was killed with chloroform, washed in warm water, afterwards in distilled water, and then placed in an oblong glass trough. The lower jaw was removed, and the ventral side opened from thorax to anus—a slit being made on either side to allow the dermis to be thrown back, and thus expose the whole of the viscera. The heart, lungs, and liver, with the gall-bladder, were detached and placed on glass plates and covered with small bell-glasses. Each was separately examined, at first dry as an

opaque object, and afterwards immersed in sterilized water and teased out with needles. The result was to confirm my previously formed opinion, that the animals were not endoparasitic in these organs.

The alimentary canal was next detached its whole length, with a portion of the mesentery; the latter was spread out and examined with 1 in. and 1/2 in. objectives, but no signs of parasitic life were visible. The alimentary canal was also examined externally its whole length, and then placed in a perfectly clean trough with some of the distilled water. The intestine was very much attenuated, due to the fact that my stock had been kept short of food for a few days. It was then opened its whole length, and examined in sections. The cloaca was carefully examined, as the ureters and the urino-seminal duct (plate XVIII. fig. 1, *f* and *g*) terminate in a short canal, at the back of the cloaca. Not a specimen of *Trichodina* was, however, found either within the alimentary canal or in the fluid in which it was immersed.

I next examined the testes and renal organs and their ducts. These were extracted, spread out on a glass plate under a lens, distilled water added, and examined by a 1 in. objective. The testes were tolerably free, an occasional *Trichodina* being seen in their neighbourhood and among the efferent ducts. But it was otherwise with the renal organs; the fluid in their immediate neighbourhood was literally alive with the *Trichodina*, which swarmed over the kidneys and amongst the ureters, at times detaching themselves and moving about, and then settling themselves down and twirling round and round with a concentric motion. Here, then, amongst the urino-seminiferous organs, was the habitat of these ecto-endo-*Trichodina*, a locality which, up to the present time, according to the authorities with which I am acquainted, had escaped the notice of old and recent investigators, the *Trichodina* being looked upon as purely ectoparasitic and free-swimming in their habits.

Having established the habitat of the organisms, I endeavoured to ascertain their relationship to the parasites of the *Hydra*.

Hydræ from a pond (known as the "reed-pond") were examined, and found free from *Trichodina pediculus;* larvæ of *Triton cristatus* were taken from another pond at some distance, and specimens of *Trichodina* were detached from the branchiæ, taken up with a pipette, and placed with the *Hydræ* in a watchglass, a small quantity of water being added. Specimens of *Trichodina* were then taken from a newly dissected newt, put into a watchglass with a small quantity of water, and one of the *Hydræ* added. The former was used as a control experiment, and attention was specially directed to the latter.

When placed in the watchglass the *Hydra* was of course con-

tracted, but after a few minutes elongated itself, and spread out its tentacles in all directions. The *Trichodina* took no notice of the *Hydra*. Some settled themselves down in a quiescent condition, whilst others would spin round with a concentric motion, after a time again putting themselves in motion. If they struck against the *Hydra* they recoiled, as it were, from the contact, and continued their course; but at no time was there any adhesion to show their ectoparasitic nature. After the lapse of an hour the *Hydra* contracted itself, and gradually withdrew its tentacles until they were mere points; in a short time they disappeared entirely, and decomposition set in; some of the *Trichodina* lived about three hours afterwards, and then died. This experiment was repeated at different times with similar results.

It was otherwise, however, with the control experiment where the *Trichodina* at once attached themselves to the *Hydra*. Both lived for days, the former seeming as much at home on the tentacles of the *Hydra* as on the branchiæ of the larvæ of *Triton*.

I tried another experiment. I isolated five newts, placing them in a dry bell-glass on some pieces of granite, and kept them without food or water for twenty-one days. I did this to know whether the fact of keeping them without nutriment would have any effect on the existence of the *Trichodina* if found. Of the five newts one died from starvation, and the others became very torpid, huddled up together, and were in a very emaciated condition. I killed two, and found that the viscera had shrunk considerably, more especially the liver. The gall-bladder was distended with gall of a light greenish colour—in the immediate change from larva to adult it is of a dark colour. I had expected to find some *Trichodina* in the thorax, but did not. The urino-seminiferous organs, however, in both specimens of newt, were swarming with animals in different stages of growth. This experiment goes to prove that a long dearth of water has no effect on the existence of the *Trichodina* as endoparasites. The other two I placed in their natural element, and they soon recovered their activity.

In reference to their vitality, I may remark that I tried in many ways to keep them alive for anything approaching the time of the control experiment, but all failed. At last, working on the assumption that they required but little oxygen, the contractile vesicle being anything but an active one, I constructed an oblong trough, with the upper edges ground flat. In this I placed the viscera, minus the lungs, liver, and heart; at the same time syringing the visceral cavity, and emptying the contents into the trough. This I covered with a plate of glass, having previously greased the edges, and placed the whole under the receiver of an air-pump. By thus excluding a certain quantity of air, I was enabled to keep most of them alive for about twenty-four hours.

In my view the species of *Trichodina* with which I have been dealing differs from *T. pediculus*, and from any other hitherto known species.

In particular they have not that hourglass form seen so frequently in *T. pediculus*, either when found on the tentacles of *Hydra*, or on the branchiæ of the larva of *Triton*. They always retain a dome-like form (fig. 2). I do not consider that this persistency of form is due to the sickly condition referred to by other writers in the case of *T. pediculus*, as all the specimens I have found have been to all appearances in a very healthy state. Again, the number of the denticles exceeds those of *T. pediculus;* the ring of the acetabulum of the former consisting of thirty, whereas that of *T. pediculus* has twenty-six. Its endoplast is band-like and curved, and the cuticle offers a greater resistance to the action of acetic acid than the denticles. The pulsations of the contractile vesicle are very sluggish.

When the creature is treated with picro-carmine I find that the acetabulum gives way, and the whole of the contents of the interior are ejected, thus leaving the lorica empty (fig. 6). The acetabulum is articulated to the body, and is easily detached by careful manipulation of the compressorium. The greatest length of the body is about 1/500 in., and the diameter 1/400 in.

I have only to add that when I first found these creatures I thought that possibly they were peculiar to the pond from which I took the newts; since then I have captured both species of Batrachians in various ponds, within a radius of four miles of Canterbury, and found that they all harboured these parasites, though in none did I find a single specimen of *Hydra*. The same result followed an examination of a dozen newts sent me by Mr. T. Bolton from Birmingham, the urino-seminiferous organs containing large numbers of the parasites.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Idioplasm and Nuclear Substance.‡—To the numerous recent contributions to the theory of heredity, a critical review is added by Dr. J. Frenzel.

In the first portion of this survey he discusses the nature of sexual reproduction, noting the different opinions as to the rôle of the nuclei, the import of the sperm protoplasm, polyspermy, &c., concluding that the real male substance is probably confined to the nucleus, though the denial of any important function to the associated protoplasm is not, as yet at any rate, justified.

The second chapter is devoted to a treatment of asexual reproduction, with a discussion as to the definitions of cell and nucleus, the striking absence of demonstrable nuclei in numerous instances, the existence of diffused "pseudochromatic" substance, and the probable morphological solution of the nucleus in various cells.

Lastly, he reviews the opinions held in regard to the real inherited substance, framing a number of evident generalizations, and as a general conclusion suggesting that the specific characters are transmitted by the nuclei, while the reappearance of the general characters of the species is ensured through the protoplasm of the egg-cell. A lucid review of many important researches is available in this lengthy paper, which does not, however, contribute any important new suggestion to the solution of the problem of heredity.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with processes of Evolution, Development, and Reproduction, and with allied subjects.

‡ Arch. f. Mikr. Anat., xxvii. (1886) pp. 73–128.

Spermatogenesis in Amphibians.*—Prof. v. la Valette St. George reports the result of his investigation of the ontogeny of the spermatozoa in some Amphibia.

In *Bufo cinereus* he reasserts what he maintained some years previously, that the tail consists not of one spiral fringe, but of two filaments united by a thin membrane. The addition of reagents effects the separation of the two tail filaments. The movements of the sperms are described. The fate of the residue of the spermatide not used up in forming the sperm is noted, but no new fact of importance is announced. In regard to *Hyla arborea* and *Rana esculenta*, several descriptive notes are communicated, and the validity of former conclusions is in some particulars corroborated. The accuracy of the author's long-since stated law of spermatogenesis is vigorously emphasized.

History of the Primitive Streak.†—Prof. J. Kollmann gives an account of the history of the so-called primitive streak in "meroblastia." Seen from the surface, the blastoderm exhibits three primitive organs: (1) the peripheral ridge, (2) the primitive streak, (3) the medullary groove and ridges. In the bird, the peripheral ring of blastoderm which marks the beginning of the area opaca first appears, then the primitive streak in the enclosed space, then the resulting primitive groove and folds, and, lastly, the medullary groove and ridges without any association with the primitive streak. So it is in mammals, though the peripheral pad is not so thick, and more transitory.

Kollmann notes as characteristics of the primitive streak (1) that it is associated with the peripheral ridge, (2) that it is at first closed in front, (3) that the subsequent primitive folds are also in association with the peripheral ridge, (4) that the primitive streak goes to form the posterior portion of the trunk, and (5) that though the chorda dorsalis is associated with it in position, it does not arise from it.

In the Selachian development the following facts may be observed:—The primitive streak is (I.) at first sickle-shaped in the posterior region of the blastoderm; it afterwards (II.) exhibits a median thickened portion, peripheral bud, and two sickle-shaped horns; from the median thickened portion the primitive groove results (III.), intruding into the area pellucida, as in birds and mammals; the folds elongate backwards, following the posterior margin of the germinal disc, and forming finally the caudal portion of the body. The primitive groove of the III. stage ought not to be termed the medullary groove, from which it is quite independent.

In regard to Teleostei, Kollmann refers to the primitive streak, the peripheral bud, the sickle-shaped streaks, associated posteriorly with the peripheral ridge, and a small region of embryonic shield lying in front of the peripheral bud.

A slight transitory constriction of the peripheral bud represents

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 385-96 (3 pls.).

† Biol. Centralbl., vi. (1886) pp. 314-9 (Bericht Versamml. Deutsch. Naturf., Strassburg, 1885).

a portion of the primitive groove. In front of the peripheral bud in the region of the embryonic shield a portion of the primitive groove emerges for a short period, in a stage corresponding to III. of the above. The author emphasizes further that the region of the primitive streak is free from the chorda, which afterwards comes into local association with it, that the medullary groove has in its first appearance no connection with the primitive groove behind it.

In Reptiles the primitive streak has the form of a bud or knob. The primitive groove is represented by the neurenteric canal, described by Kupffer and Benecke. This canal has all the characteristics of a primitive groove: (1) it is found in the region of the bud, as in Selachia and Teleostei; (2) it is closed in front; (3) it is utilized in forming the posterior portion of the body; (4) the chorda comes into subsequent local connection with it; (5) it comes to be a continuation of the neural canal; (6) the margins of the neurenteric canal (or primitive groove) represent the primitive folds, for they help, as in selachians, birds, and mammals, to form the medullary groove; finally, the area of this primitive streak extends into the peripheral ridge, and is there associated with sickle-like horns. The primitive streak or neurenteric canal of reptiles is therefore no form of gastrula. The result of Kollmann's interpretation is to maintain in the different groups an intimate homology in the characters of the primitive streak and in the phases which it exhibits.

Germinal Layers of Chelonia.*—Prof. K. Mitsukuri and Mr. C. Ishikawa have investigated the formation of the germinal layers in *Trionyx japonicus;* they find a passage which commences at the blastopore and takes a forward and downward course to the ventral surface, in the middle of which it opens by a circular orifice; at the dorsal lip of the blastopore the ectoblast is continuous with the chorda-entoblast; the conversion of the axial part of the entoblast into chorda-entoblast proceeds from behind forwards. At the floor of the blastoporic passage the ectoblast fuses with the entoblast, and at this point the entoblast is given off posteriorly in all directions through 180°. The line of the primitive streak is very short. The med an mass formed by the fusion of the three layers appears for a short space on the dorsal surface, and may be regarded as the remnant of the yolk-plug of Rusconi.

The mesoblast commences as a string of cells placed dorsally to the enteric entoblast and ventrally to the ectoblast, but it is distinct from both; it only later extends into the region in front of the blastoporic passage, and here it arises as a paired mass, one part of which is always continuous with the chorda-entoblast, and the other with the exterior entoblast. The notochord is first completed in the middle, and then extends backwards and forwards.

With regard to the formation of the blastoporic passage, the authors somewhat diffidently suggest the following; at the end of segmentation the blastoderm becomes divided into two primary layers; but when the differentiation of the ectoblast has reached the

* Quart. Journ. Micr. Sci., xxvii. (1886) pp. 17–48 (4 pls.).

future dorsal lip of the blastopore, it becomes deflected downwards and continuous with the axial strip of the lower-layer-cells. In the more lateral parts the ectoblast continues to be differentiated and the cells meet again in the middle line a little way behind the blastopore.

Discussing the results of their observations, they point out that the agreement between the development of *Amphioxus* and the Amphibia on the one hand, and the Reptilia on the other, is as complete as could be desired, due allowance being made for the necessary differences between holoblastic and meroblastic eggs; their studies confirm the conclusions of Hertwig, while they contradict the views of Strahl, who has opposed Hertwig.

Oleaginous Spheres in the Ova of Teleostean Fishes.* — Mr. E. E. Prince thinks that there is little value in the division of pelagic eggs into those with one or more oil-globules, and those that are not so distinguished, which has been suggested by Messrs. Agassiz and Whitman; the ova of closely allied species exhibit the utmost diversity in this respect. Most Gadoid ova are, for example, without the spheres, but in the ling (*Molva vulgaris*) there is a single oleaginous sphere of a pale green tint. The spheres may be transferred from one region of the yolk to another, but the normal position is at the vegetal pole, and thither they always return when the rotated yolk comes to rest. The precise chemical nature of these large globules is still uncertain, but their composition appears to be allied to the lecithin derivates of albumin. It is possible, therefore, that they have an ancestral significance; the yolk matter of the Teleostean ovum was, Balfour thought, once greater in bulk than it is now, and if, as the vitelline mass diminished, the lecithin did not decrease in the same degree, globules would be formed such as are found in so many Teleostean eggs.

Embryology of the Opossum.†—Prof. E. Selenka communicates a short report on the development of the opossum, and origin of the mammalia. After segmentation has ended, the egg consists, from outside inwards, of a zona radiata, a layer of nutritive yolk, the ectoderm, the endoderm, and the yolk-cavity. From the primitive groove, an anterior proliferation forms the chorda dorsalis, the two mesoderm folds are formed at the sides. Five days after fertilization the amniotic duct is closed. There is no transitory ectoderm, and no formation of villi. The nutrition of the embryo is effected solely by the osmosis of uterine lymph through the chorion. The very loose attachment of the egg is effected by the persisting zona. The nuclei of the striped muscle fibres lie axially.

Structure and Development of Feathers.‡—Dr. R. Klee gives a useful account, supplemented and corrected by his own observations of what is known in regard to the structure and development of

* Ann. and Mag. Nat. Hist., xviii. (1886) pp. 84–90.

† Biol. Centralbl., vi. (1886) pp. 283–4 (Bericht Versamml. Deutsch. Naturf., Strassburg, 1885).

‡ Zeitschr. f. Naturwiss., lix. (1886) pp. 110–56 (1 pl.).

feathers. In his investigations young chicks and ducklings within the egg (from the sixth to the tenth day) were treated for a few minutes with a concentrated solution of corrosive sublimate at 50° C., and were then washed with dilute alcohol. Relative portions were hardened in alcohol and stained with picro-carmine. The same method was applied in the study of feather regeneration.

The first feathers or dunes are briefly discussed in their primitive form and then in their development. The extension of the growing epidermis is referred to in explanation of the origin of the folds which give rise to feathers and similar structures. Into the papilla formed from the thin outer "epitrichium" and the mucous layer, a nourishing cutis papilla penetrates, richly furnished with capillary branches. A number of clefts appear in the epidermis, and between these elongated cells of the cutis insinuate themselves, from the apex downwards. These clefts mark off the principal rays of the future dune, and the epidermic material enclosed between each two clefts serves for the construction of each medulla-containing ray. While this stellate notching is progressing, the papilla is still growing in length. In consequence of the insinuation of the cutis within the clefts, the outer epidermal cells come into more nutritive relations and become cylindrical like those of the mucous layer. A capillary lies in each corner of the stellate figure. The cylindrical cells at each side of the cleft begin to extend peripherally, and become cornified; the round cells which they enclose as in a tube, form the central medullary cells. The more peripheral round cells which are not included go to form the secondary rays associated with the above-mentioned tubes or principals. The cylindrical cells also share in forming the basal portions of the secondaries. Meanwhile the cutis papilla is dying. The basal piece of the feather is the undivided root of the papilla. The "epitrichium" is loosened during the folding or notching, rapidly becomes horny, and is, as is well known, thrown off when the young bird leaves the egg. A considerable number of different forms of dunes are then described.

After describing briefly the familiar structure of the adult feather, and noting especially how the superior margin of each *radius* is folded so as to form a perfect groove in which the *hamuli* of the anterior radius lie, Dr. Klee passes to discuss the development. Even within the egg the apex of the future feather appears at the base of the dunes. The whole papilla sinks deeply in the skin. The capillaries multiply in number, more than a hundred being often present. The number of epidermic layers is also very considerable. More numerous clefts arise as before, the corium insinuates itself, round cells become cylindrical. Two associated rows of the latter enclose, as before, a number of round cells, forming the future medulla. The majority, however, do not form these *rami*, but retaining their disposition in two rows form the *radii*. The cylindrical cells composing each row stretch peripherally, and becoming bent form the *cilia* or *hamuli*.

The development of the shaft and after-shaft, the nature of the calamus, and the modifications of the cutis papilla are then discussed.

The frequent statement that "after the full development of the feather, the calamus is constricted, and the cutis papilla dies," is denied, since the calamus is never wholly constricted, and before the feather is half-grown the upper portion of the papilla is dead. The throwing off of the "epitrichium" layer, and of the horny sheath from the stratum corneum superius is then described.

The process by which the outer and medullary cells undergo horny change, the origin of the pigment from wandering cutis cells and independently within the outer cells of the radii, the different forms and distribution of permanent feathers, the phenomena of moulting, the homologies of scales, feathers and hairs, and lastly the historic evolution are briefly discussed.

Monstrosities in the Egg of the Chick.*—M. C. Dareste has made a number of fresh observations on the production of monstrosities in the egg of the chick by a modification of the germ previous to incubation. He finds that eggs put to incubate four days after laying gave no monsters; of eight eggs he found that of those put to incubate after five days two, of those put after six days one, and of those put seven days after, three produced monsters. He comes to the conclusion that the diminution of the vitality of the germ, which determines the teratological evolution, may be, at least at elevated temperatures, very precocious; as normal and monstrous embryos were found side by side, it is not the incubatory process that is at fault, there must be some modification of the germ anterior to incubation. This can only be explained by a reference to that individuality which, as the author has long since shown, plays so great a part in teratogeny. What these anterior modifications are we cannot now say, for we only know them by the result of their influence on the embryo.

Influence of Gravity on the Frog Ovum.†—In reporting Prof. G. Born's recent researches on hybridization, a brief review may be given in the first place of his previous investigation as to the influence of gravity on the frog ovum. Pflüger had shown that ova fixed in a given position when the gelatinous envelope was not completely swollen, retained this position both externally and internally. This method was utilized in order to investigate what happened when definite regions were placed uppermost. If the clear region was directed upwards, and it is known from the way the egg floats, &c., to contain the heavier material, a readjustment took place. The specifically heavier albuminous substance slid downwards, the lighter was gradually forced to the top. So it happens within the mother in the ova fixed with the clear region uppermost. The process is complicated, however, by a number of factors:—the superficial layers are firmer than the more fluid interior; the interior matter is emulsion-like and viscid, not mixing readily with the rest, so that in movement sharp bounding layers are formed; and finally the whole sphere is influenced by the pressure of the imperfectly swollen gelatinous envelope.

* Comptes Rendus, ciii. (1886) pp. 355–6.
† Arch. f. Mikr. Anat., xxiv. (1885) pp. 475–545 (2 pls.).

Prof. Born describes at length the various phenomena exhibited during the readjustment of the material in different positions of the ovum. In ova in their normal environment, fertilization seems markedly to accelerate the readjustment. In unfertilized ova the change takes place very much slower. The penetrating sperm appears to effect a change in the consistence of the egg substances, making them more fluid.

In following the history of the sperm, Born has shown that while there is no special micropyle, the sperm cannot enter at any place, but only in a region covered with the pigmented cortical layer. It never enters in regions where the white yolk is on the surface, and this is known to be the more compact.

Born seeks to explain the level and horizontal position of the nuclear spindle in the axis of the normal ovum in reference to the directive influence exercised by the protoplasm on the nucleus. This varies according to the character and distance of the protoplasmic portions, and the horizontal position of the spindle is the only one in which the directive influences would be in equilibrium. This theory is developed in detail in regard to the different divisions of the ovum, both in its normal environment and when fixed.

The author inclines to explain hereditary transmission not directly in chemical terms, but in reference to the arrangement of minute elements. Now he has shown that though the general protoplasm be literally turned upside down, and moved about to such an extent that almost no particle retains its normal position in relation to adjacent particles, yet the resulting tadpole is normal: the specific transmitting structure must therefore lie in the nucleus which undergoes no visible change in the readjustment brought about by gravity. This agrees with the independent results reached by Roux. Born compares his observations and conclusions throughout with those of Pflüger, O. Hertwig, Roux, and Rauber, who have lately worked at the same problems.

Embryology of Torpedo marmorata.*—Prof. J. v. Perenyi finds that the meroblastic ova of *Torpedo marmorata* are surrounded by a fine structureless vitelline cuticle; the nuclei which appear beneath the blastoderm in the trophoblast sink downwards and take on the characters of cells; these partly give rise to the endoderm, and partly form nutrient yolk; the primary blood-cells appear to arise from them. The lower wall of the enteron is not formed, as in *Pristiurus*, by the first-mentioned cells of the nutrient yolk, but by the constriction of the lateral parts of the embryo. The notochord is constricted off from the endoderm in the form of a canal, which appears first at the middle, then at the anterior, and lastly at the posterior region of the embryo. The membrane which invests the chord is formed of cells, and should, therefore, be called membrana propria rather than cuticula chordæ. When the termination of the chord undergoes division, its furcate portions grow between the ectodermal and endodermal walls of the developing neurentric canal. The tip of the

* Zool. Anzeig., ix. (1886) pp. 433–6.

notochord extends as far as the anterior end of the hypophysis; during development the chord becomes so enclosed by the cartilaginous chordal sheath that it persists only as an irregular stellate mass in the centre of the biconcave bodies of the vertebræ. The subchordal rod is formed of mesodermal cells, and in embryos 15–20 mm. long it unites with the cells of the skeletogenous sheath of the chord, in the formation of which it takes part. This sheath is derived from those cells of the splanchnopleure, which become separated off when the somites are formed; it is absent within the shell when the membrana propria is alone developed; beyond it the sheath touches and is not separated from the connective-tissue cells which arise from the somites. In the cells of the sheath secondary formation of cartilage occurs, and the cells surround it in a plexiform fashion, while calcareous salts become deposited in the plexus. In the embryo the skeletogenous layer forms an important part of the vertebral column, but in the adult it only forms delicate calcified rings within the vertebræ, and an important part of the intervertebral portion.

Reproductive Elements of Myxine glutinosa.*—Mr. J. T. Cunningham finds that the firm membrane inclosing the ripe deposited ovum of *Myxine* is a primary egg-membrane produced within the follicle, and that the polar threads are processes from this membrane. The membrane itself is single, and, as it has minute pores perpendicular to its surface, it is a zona radiata; it is homologous with the single or double zona radiata of *Petromyzon* and of Teleosteans. At that pole of the ovum at which the germinal disc is situated the membrane is perforated by a micropyle; this last is produced by a process from the follicular epithelium. The immature testis of *Myxine* consists of a thickened border of the mesorchium containing more or less spherical capsules, which are filled with hyaline nucleated spermatoblasts; a large proportion of immature *Myxine* are hermaphrodite, the posterior portion of the reproductive organ containing testicular capsules, similar in structure to those of the male; in these, but not in the male, the author found spermatozoa; the males are very rare.

Development of Fundulus heteroclitus.†—Mr. J. A. Ryder finds the zona radiata of the egg especially well developed, and thickly covered with very fine filaments which have not hitherto been noticed in any Cyprinodont fishes, though known in *Belone*, *Exocœtus*, and others. By the intertwining of these filaments the eggs are bound together, and are suspended to seaweeds, &c. The oil-globules are small, numerous, and situated a little to the side of the blastodisc.

Development of the Mud-minnow.‡—The ova of this species are laid singly, and adhere to aquatic plants by means of their general coating. Mr. J. A. Ryder finds a group of small oil-globules immediately below the blastodisc, which become, as the latter extends, more and more scattered over the surface of the ovum. There is a very active amœboid movement of the substance of the yolk at the

* Quart. Journ. Micr. Sci., xxvii. (1886) pp. 49–76 (2 pls.).
† Amer. Natural., xx. (1886) p. 824. ‡ Ibid., pp. 823–4.

time of the formation of the blastodisc. The young *Umbra limi* is hatched on the sixth day. The air bladder appears three days later, behind the pectorals. By the sixteenth day the pigment has become so abundant as to render the larva very dark. Immediately after hatching, the notochord extends into a lobe projecting at the end of the tail. This lobe, which becomes absorbed as growth proceeds, is homologous with the "opisthure" of *Chimæra*, and of the larval *Lepidosteus*. A similar but smaller lobe is present in the young pike; but no teleostean approaches the Rhomboganoids in this respect, so closely as does *Umbra*.

Mode of attachment of the Ovum of Osmerus eperlanus.*—The ovum of the smelt is usually stated to be attached by a short ligament to solid objects. This "ligament" Mr. J. T. Cunningham finds to be, in reality, the outer layer of the zona radiata. The zona is divided into two more or less distinct layers, the internal layer having very numerous fine pores, and the outer having fewer pores. When the egg is laid the external layer breaks over a small area and unrolls in such a way that it remains attached to the egg over a circular area, whilst the rest of it serves as a suspensory membrane. Before being laid the ovum possesses, outside the zona radiata, a delicate structureless membrane, derived probably from the connective-tissue layer of the follicle.

Origin of Blood-corpuscles in Teleostean Embryos.†—Herr H. E. Ziegler has continued his researches on the embryology of Teleosteans in an inquiry into the origin of the blood-corpuscles.

(*a*) The corpuscles do not arise from cells of the yolk, as has been stated. There are no cells in the yolk; but large oval nuclei, undergoing modifications apparently of a degenerative nature.

(*b*) When the blastoderm has grown round more than two-thirds of the egg, and the space between the parietal plates has extended (about the 13th day), a strand of cells may be observed at the side of the foregut, below the splanchnopleure. The strand extends forwards medianly into the undifferentiated mesoderm mass of the head. As the cavity between the parietal plates enlarges, and as the foregut is medianly separated off from the yolk, the bands of cells above referred to, meet medianly and form the endothelium of the heart.

(*c*) Before any blood-corpuscles appear in the vessels, the sinus venosus contains a few which seem to originate as follows: The protovertebræ are not sharply defined laterally in the region of the sinus venosus, they protrude between somatopleur and ectoderm in such a way that the connection of the cells becomes loose laterally, and amœboid cells appear to find their way between the splanchnopleure and the yolk, reaching and entering the sinus venosus.

(*d*) A mass of cells described by Oellacher becomes modified into the median vein running below the aorta, and into the blood-corpuscles which fill this vessel. Before this mass becomes connected with the system, a large number of the cells are given off. In the middle

* Proc. Zool. Soc. Lond., 1886, pp. 292–5 (1 pl.).
† Biol. Centralbl., vi. (1886) pp. 284–5.

portion of the trunk masses of cells pass down to the yolk by narrow slits, between the gut and the vertical portion of the parietal plates (17th day). There they accumulate beside the embryo, and move peripherally beneath the splanchnopleure. They give rise to the first vessels of the yolk, and especially to the peripheral vein of the *area vasculosa*. These masses of cells are enveloped by flat cells; their origin is comparable to a budding of the mother blood-vessel; from the latter as they grow they derive their contained corpuscles. When the marginal vein has developed and come into connection with the sinus venosus (19th day), the latter is considerably enlarged, and exhibits a great number of blood-corpuscles.

Larval Theory of the Origin of Tissue.*—Prof. A. Hyatt endeavours to prove a phyletic connection between Protozoa and Metazoa, and to show that the tissue-cells of the latter are similar to asexual larvæ, and are related by their modes of development to the Protozoa. This seems to be indicated by the fact that the tissue-cells exhibit highly concentrated or accelerated modes of development according to a universal law of biogenesis.

No bushy colonies of cells are built up in the Metazoa, except in cases of incomplete segmentation of the ovum. These forms are skipped, and the complex colonies which arise by fission consist of "zoons" divided by distinct walls. As a result of the thickening of the mesembryon, the habit of budding was more or less suppressed, so that the higher types are to be considered as individuals with a highly plastic form, liable to excessive outgrowths, but not as branching Metazoa.

The author advocates the doctrine of the common but independent origin of types, and urges that palæontology carries back their origin further and further. Early geologic, like early ontogenetic history exhibits a more highly concentrated and accelerated process in evolution than that which has occurred at later periods of the earth's history

Mechanics of Development.†—Dr. W. Roux continues the general character of his previous researches in a memoir on the mechanics of development in the embryo, which forms one of the pioneer explorations of this but little known field. He distinguishes *self-differentiation*, where the specific nature of the modification is determined by the energies of the system, from *correlative differentiation*, or change determined by action and reaction between the system and its surroundings. Having previously shown, in contrast to Pflüger, that the formal development of the egg is independent of gravity, he notes this as a case where self-differentiation predominates. The influence of electrical stimulus and of mechanical injury at various stages are discussed in detail. Thus frog ova pricked with a needle, so that some of the material was lost, often developed into smaller moribund forms. After considerable loss, however, normal development frequently

* Proc. Bost. Soc. Nat. Hist., xxiii. (1885) pp. 45–163.
† Zeitschr. f. Biol., xxi. (1886) pp. 1–118.

occurred. Definite injuries to the ovum produced definite defects in the embryo. Many portions of the embryo seem to exhibit self-differentiation. The nature of the injuries makes a report of their details difficult: the above illustrates their general character.

β. Histology.*

Nuclear Division in the Spinal Cord.†—Prof. A. Rauber seeks to answer the following questions:—Are the figures of nuclear mitosis observed in the spinal cord, similar to those observed elsewhere? do other than mitotic modes of division occur? in what layers of the medullary cord do the nuclear divisions occur? what axis or axes of division predominate? at what stages, &c., do the mitoses occur? His research, so far as communicated, relates to the Batrachia.

Historical. In 1881, Altmann's researches on the embryology of the chick seemed to lead him to these striking conclusions:—(*a*) that all diverticula of ectoderm and endoderm, and these two layers themselves when more than one stratum thick, exhibited nuclear division only in that layer which represents the outer side of the original ectoderm or endoderm—in the stratum, in other words, furthest from the mesoderm. The spinal cord thus exhibits nuclear division only in the layer next the central canal. (*b*) The planes of division are almost exclusively parallel to the bounding surface. The cells multiply in a superficial direction, and not in the direction of the thickness. The first result suggested at once, among other questions, an inquiry as to the nutritive supply which determined the occurrence of proliferation in such a position, nor is the second result less striking in its suggestion that the increase in thickness is really secondary, and dependent on the displacement of the cells which multiply only in a superficial direction. After discussing the import of these results, Rauber traces the course of research, showing how Uskoff fully confirmed Altmann, while Pfitzner describes nuclear figures through the entire thickness of the wall. In 1882 Rauber noted the presence of mitosis in all the layers, and even most abundantly in the outermost. Vignal, however, again confirmed the results of Altmann and Uskoff, to which the research of Koganeï on the retina was also, for the most part, corroboratory. A recent research on the embryo of *Tropidonotus natrix* by Merk, also partially supports the conclusions of Altmann. In the spinal cord of this form there is a single proliferating layer, furthest from the mesoderm, next the central canal. In the brain and in the retina this ventricular proliferating layer is present only in the earlier periods of development; afterwards the deeper layers also exhibit figures of division, which are then more or less absent from the ventricular sheath; at different periods the position of proliferation changes. In the cerebellum, division occurs, from the first, in all the layers. Merk has thus demonstrated the existence, in brain and retina, of "ultra-ventricular" mitoses.

* This section is limited to papers relating to Cells and Fibres.

† Arch. f. Mikr. Anat., xxvi. (1886) pp. 622–44 (1 pl.).

Rauber's observations. After this indispensable historical summary, Prof. Rauber communicates the result of his own researches:—(*a*) In a section of *Tropidonotus*, exactly the same as that described by Merk, Rauber notes the distinct presence of mitoses in ultra-ventricular regions. In the two outermost mitoses, occurring in the outermost layer of cells, the planes of division are horizontal; in those further inwards, approximately so. (*b*) The innermost mitoses emphatically predominate, and the direction of division is generally radial, occasionally somewhat oblique, and rarely tangential. (*c*) In the brain of a young tadpole, proliferation occurs not only in the layer next the cavity, but in all the other layers. The growth in thickness is partly independent, through the multiplication and growth of the original epithelium and by the formation of new layers by tangential division, and partly secondary in consequence of superficial multiplication of the epithelial layer by radial division. (*d*) In the spinal cord of the tadpole, as in that of *Tropidonotus*, mitoses occur in the outer, as well as in the inner strata. The increase in thickness is therefore as in the brain, both direct, and indirect. (*e*) Similarly with the retina, the pre-eminently proliferating layer is the external, that which originally bounded the primitive eye-ventricle, and is adjacent to the subsequent pigment layer. Mitoses occur, however, in the other layers; the direction of division is pre-eminently, but not exclusively, radial, and the growth in thickness is both direct and indirect. (*f*) In the olfactory groove, the favourite proliferating layers are the mesodermal, and those next to it. Mitoses occur, however, in all the strata. A continuation relative to other Vertebrates is promised.

Indirect division in Cells of Tumours.*—M. V. Cornil has observed division by threes in the cells of two tumours, both of which were epitheliomatous. Sections revealed the fact that the trilobate chromatic filament became completely separated into three distinct plates within one nucleus.

Import of Cytozoa.†—Prof. J. Gaule has lately developed his theory of the cytozoa which are regarded by most authorities as parasites in the blood. He still adheres to the reasons which seem to him to disprove the simply parasitic character of these elements.

The typical cytozoa have a somewhat complicated structure. They contain an unmistakable nucleus, and their protoplasm consists of two portions, on the one hand of a substance occupying the two points of the cytozoon ("nigrosinophilous substance"), and, on the other, of two granules lying in a clear space at each side of the nucleus ("eosinophilous substance"). The cytozoon thus unites the nigrosinophilous substance characteristic of amœboid cells of the (frog) blood, and the eosinophilous substance composing the granules of the plasma. These two substances occur, indeed, variably in all cells. Almost every kind of cell may form a cytozoon. The cytozoa vary considerably within the same individual, and very greatly in different genera,

* Comptes Rendus, ciii. (1886) pp. 78-80.

† Biol. Centralbl., vi. (1886) pp. 345-51 (Bericht Versamml. Deutsch. Naturf. Strassburg, 1885).

frequently exhibiting cilia for instance, as in the salamander and in man.

When the blood leaves the vessels, the cytozoa leave the corpuscles and melt away in the fluid. The blood must therefore be fixed by a special method (not noted).

In discussing the import of these elements, Prof. Gaule proposes two questions:—(1) What rôle do they play in the life of the organism? and (2) From what cells do they originate, and what cells do they become? Their history, according to Gaule, is as follows:—In the spleen, and exceptionally in the liver, they leave the red blood-corpuscles, and find their way into certain cells rich in protoplasm, which Gaule terms "nurse-cells." Groups of these nurse-cells lie scattered in the frog spleen like the follicles in the spleen of mammals. The groups increase greatly in size, and their appearance becomes altered. The nigrosinophilous protoplasm becomes filled with granules of a peculiar pigment formed from that of the blood. During this process the protoplasm exhibits a beautiful iron reaction with ferrocyanate of potassium. In these nurse-cells the young blood-corpuscles originate, and the whole process lasts from autumn to spring.

While the new corpuscles are thus in making, the old ones from which the cytozoa have migrated, gradually die. The quantity of blood decreases gradually throughout winter, and the process can be experimentally regulated, by poisoning with pilokarpin, or merely by the variable environmental influences of imprisonment. The unwonted warmth, dryness, and light form an artificial springtide to the frogs, and the blood-manufacture goes on apace. Instead of red, white corpuscles may also be formed from the cytozoa. In the former case, the cytozoa secrete a fatty substance, which forms an enveloping layer, at the borders of which the pigment appears. In the latter case, the cytozoa break up, within the nurse-cells, into their three main constituents already noted. From each of these a cell may arise.

In summer, when the frog is eating industriously, blood-corpuscles are formed in quite another way. The phenomenon occurs only in sexually mature frogs, differs in the two sexes, and is associated with the sexual decoration of the skin. It is probable that the cytozoa stand in some direct connection with the sexual function. Dr. Miescher has shown in the case of the salmon, that during the fasting period, the blood is detained in the spleen, and peculiar modifications occur in the muscles, which lead finally to certain constituents of the muscles being utilized for the elaboration of the sexual organs. So in the frog, peculiar modifications occur during the fasting period, which lead to this—that portions of the striped substance pass into the nuclei within which peculiar cells are formed. These cells pass into the blood, reach the liver, where they become modified, their contents passing into the protoplasm of the liver cells. It is then that the blood-corpuscles show the first trace of cytozoa. The elements originating in the muscles, evoke the formation of cytozoa, and are destined for the elaboration of the sex-products. The cytozoon is an individual which unites the constituents for the other tissues of the body. It

may further itself break up into smaller elements, karyozoa and plasmozoa, which play an important part in all tissue formation. The cytozoon is the fundamental element; the formation of embryonic layers, and the differentiation of sex are explicable in terms of cytozoon modifications. These speculations are further developed.

When considered *per se* the cytozoa are comparable to the sexual elements of filamentous fungi. Their mycelium is the nigrosinophilous protoplasm, their hyphæ the chromatin threads of the nucleus, their gyniosium the plasmosoma! But the development of the fungus is never completed in the tissue-cell, the individual-cell is imperfect; for its completion the cell of another tissue is necessary. On this the life of the whole organism depends. Prof. Gaule asserts that his views are supported by numerous physiological facts, and he finds a key to the understanding of organic structure in his theory of the import of the cytozoa.

Nerve-endings in the Cutaneous Epithelium of the Tadpole.*—Mr. A. B. Macallum, in his second essay on this subject,† states that there are two plexuses of non-medullated fibres, one wide-meshed set some distance below the corium, and the other very narrow-meshed, and immediately beneath the epithelium. The first may be called the primary or fundamental plexus, and it sends up fibres which unite with the secondary or subepithelial plexus; from the former also fibres pass up and terminate in swollen bead-like bodies between the epithelial cells; from the latter minute fibres arise which either terminate within the epithelial cells, near their nuclei, or between them. The fibres which enter cells of the basal and intermediate layers of the epithelium are provided with the figures of Eberth; these decrease in size as the cells containing them show fewer and fewer signs of vitality; the figures appear, therefore, to protect the intracellular ends of the nerve-fibrils from the vital processes of the cells. These figures are the production of the intracellular end of the nerve-fibrils, and are formed by or from the cell-protoplasm. Free intercellular nerve-endings are due to the intercellular fibres losing the cells with which they are connected, and such are, consequently, most common between the superficial cells.

Histology and Physiology of Ciliated Epithelium.‡—Following up the experiments which Prof. Grützner § made upon injured ciliated mucosa, in which it was seen that the injury affected only the portion below the cut, Herr A. Just has studied, in the living organism, the exact changes exhibited by the adjacent cells. In the pharyngeal and œsophageal mucosa of living frogs, definite injuries were cleverly effected by means of burning, and Grützner's results were confirmed.

The ciliated areas or grooves in the normal skin above the injury are described and contrasted with the appearance of the adjacent area below. The ciliation is stopped or checked, moribund pulsations are

* Proc. Canadian Inst., iii. (1886) pp. 276–7.

† See this Journal, *ante*, p. 218. ‡ Biol. Centralbl., vi. (1886) pp. 123–6.

§ Breslauer Aerztl. Zeitschr., 1882; 'Physiologie des Flimmerepithels,' Leipzig, 1883.

abundantly observed, the ciliated areas or grooves are less definite, and the colour of the affected area is turbid and slightly yellow. The mucous cells exhibit marked modifications, e.g. a marked abundance of disproportionately large granules, and a longer, narrower shape. In the ciliated cells, the cilia disappear, or become fused together, or become, less frequently, markedly smaller, as Drasch * has already noted. The epithelium generally is much less conspicuous, and the ciliated grooves much flatter. The investigation, which cannot yet be regarded as complete, was extended to other amphibians, and to the rabbit.

Direct Communication of the Blood with the surrounding Medium.†—Herren C. F. and P. B. Sarasin describe the tubules of communication in *Epicrium glutinosum*, by means of which the contents of the blood capillaries communicate with the intercellular spaces and so with the outer world. Among the Mollusca they examined a *Planorbis* and a *Paludomus;* they found gland-ducts of about the diameter of an epithelial cell and tubules with a diameter one-tenth or one-twelfth of this, which end freely in the subepithelial tissue which, as we know, is filled with blood. These tubes appear to subserve respiration, and cannot allow of the sudden entrance of a quantity of water. Among the Oligochæta two species of *Perichæta* were found to have considerable intercellular spaces between the cells of the epidermis, and these are free on the side of the cuticle, which is traversed by a number of pores, the larger of which correspond to the glandular cells. Numerous blood-vessels pass into the epidermis. In the land-leech of Ceylon very similar structural relations were observed. The authors think that these undoubted cases of communication between the blood and the surrounding medium are all of advantage in the process of respiration.

γ. General.‡

External Markings.§—Prof. T. Eimer, in resuming his well-known opinions in regard to the external markings of mammals, molluscs, butterflies, &c., lays stress on the origin of species from constitutional causes, without any primary relation to utility.

Methods of Defence in Organisms.‖—Mr. C. Morris adds some remarks to his previously published paper on this subject,¶ in which he especially treats of the sponge from the point of view of defence. Of all animal types this is the one which is the least protected by defensive appliances; what adaptation there is appears to reside in the peculiar system of inhalent and exhalent apertures, for the currents enter only at minute apertures, and close up completely when not in

* SB. K. Akad. Wiss. Wien, lxxx. (1879), and lxxxii. (1881).

† Arbeit. Zool. Zoot. Inst. Würzburg, viii. (1886) pp. 94–101.

‡ This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

§ Biolog. Centralbl., vi. (1886) pp. 285–6. (Bericht Versamml. Deutsch. Naturf. Strassburg, 1885).

‖ Proc. Acad. Nat. Sci. Philad., 1886, pp. 25–9. ¶ *Ante*, p. 214.

use; did they enter by the large exhalent orifices their large-sized enemies could enter also. The strong current of outflow tends to drive away all enemies that are not strong swimmers. The spiculation of most existing sponges must also be regarded as a powerful means of defence.

The author points out the differences in the way of defence between animals and plants; the appliances of the former are either mechanical, as in the oyster, or motor, as in man. Among plants there is mechanical defence only, and only few have the power of making aggressive motions.

Throughout the whole of the organic realm there seems to have been a continued evolution of more rapid and varied powers of motion, and with this there has been an increase in mentality; this latter, or the evolution of the brain, is a consequence of that of the body, not the reverse.

Correlation of Animals and Plants.*—M. N. Gribaut has repeated, with carps and leaves of *Potamogeton lucens*, the experiment of Priestley on the influence of green plants on the respiration of animals, and finds that carps when alone die of asphyxia, while those placed with the green plant continue to live and respire freely.

B. INVERTEBRATA.

Parasites of Balænoptera borealis.†—Mr. R. Collett gives a figure of the copepodan parasite *Balænophilus unisetus*, which was described by Aurivillius from *B. Sibbaldii*, and has not before been found on any other whale; it occurs in myriads on the baleen plates. In the intestines two *Echinorhynchi* were found in very great abundance; one of them is, apparently, *E. porrigens* Rud.; the other appears as yet to be undescribed, and may be called *E. ruber*. It is 25 mm. long, has four rows of spines on the proboscis, and ten to twelve on the rostellum. The sexes were both well represented, and do not appear to differ in length, colour, or general appearance.

Mollusca.

Morphology of the Mollusca.‡—M. E. L. Bouvier has studied the amphipodous *Ampullaria*, and an examination of its nervous system has shown that this Gastropod is both chiastoneurous and zygoneurous. The penis is an appendage of the mantle, and is innervated by the right pallial nerve; this is a very rare, if not unique, arrangement. The epipodium is supplied by the commissural ganglia, and not, as Ihering states, by the pedal; it is therefore a pallial formation, and it shows that the so-called epipodial structures are not all of the same morphological significance, for some are appendages of the foot and others of the mantle or body-wall.

As in all the Ctenobranchiata the gill and false gill are inner-

* Comptes Rendus, ciii. (1886) pp. 418–9.
† Proc. Zool. Soc. Lond., 1886, pp. 255–9.
‡ Comptes Rendus, ciii. (1886) pp. 162–5.

vated by the supra-intestinal branch of the commissure, it may be concluded that in *Ampullaria* and all other Ctenobranchs the gills are the homologues of the left gill and so-called olfactory organ of the Zeugobranchiata; this is in opposition to the opinion of most writers, who homologize the large gill of the Ctenobranchs with the right gill of Zeugobranchs, and the false gill with the left. The author concludes that the systematic position of *Ampullaria* is with the zygoneurous Tænioglossata, and that it stands nearest to the Calyptræidæ.

Morphology and Relationship of Cephalopods.*—In a critical review Prof. C. Grobben continues his studies on the morphology of Cephalopoda, maintaining his former view that the primitive form is most nearly represented by *Dentalium*.

I. *Innervation of arms.*—In discussing the nature of the arms, over which there has been so much controversy, Grobben notes the facts which appear to him fatal to the theory which would regard them as modifications of the anterior portion of the foot. Relying on the researches of Dietl and others, he notes especially (1) that the cerebral ganglion is continued downwards round the œsophagus, that a portion of the sub-œsophageal mass apparently belonging to the pedal ganglion really belongs to the cerebral; and (2) that of the nerve-fibres supplying the arms many undoubtedly terminate in the downward directed portions of the brain, but others may be traced through the anterior and posterior lateral commissure into the posterior basal lobes of the cerebral ganglion. These facts suggest that the arm-nerves and brachial ganglion owe their origin not to the pedal but to the cerebral ganglion, and point to Ihering's theory that the brachial was really a separated portion of the cerebral ganglion.

Resuming the facts established in regard to the central nervous system of *Nautilus*, Grobben notes Ihering's conclusion that all the tentacle-nerves are cerebral nerves. Grobben refers the tentacles to an original position at the sides of the mouth, as in the cephalocones of *Clio*. He agrees with Ihering in maintaining that in the *Dibranchiata* the anterior lateral expansions of the cerebral ganglion of *Nautilus* have been brought into contact in the inferior middle line by continual shortening of the sub-cerebral commissure. Sections show that the anterior lateral commissure contains exclusively nerves for the arms, while the greater portion of the fibres pass by the posterior œsophageal commissure, which undoubtedly represents the united cerebro-pedal and cerebro-visceral commissures. He therefore regards the anterior lateral commissure as an anteriorly displaced portion of the posterior.

II. *Development of the arms.*—Grobben criticizes Ray Lankester's conclusions drawn from the development of the arms. As to the *Pneumodermon* larva where the arms appear on the foot at a distance from the head, the fact is emphasized that the innervation is still from the cerebral ganglion. The cirri of *Dentalium* cannot corre-

* Arbeit. Zool. Inst. Univ. Wien (Claus), vii. (1886) pp. 61–82 (4 figs.).

spond to the ctenidia of the archimollusc as Lankester suggested, not only because of their position at the sides of the mouth, but also because of their innervation from the cerebral, and not, like the ctenidia, from the visceral ganglion.

III. *Comparison with Dentalium.*—Prof. Grobben supports his views by a morphological comparison of *Dentalium*, *Nautilus*, and *Sepia*. He defends his "orientation" of the body of *Dentalium*, in which of the two mantle apertures, the larger, through which the foot projects, is turned forwards and downwards, while the narrower lies at the apical pole of the body. The mantle-cavity occurs at the posterior side of the body. He discusses corresponding relations in the course of the alimentary canal, &c., and shows the derivation of the *Dentalium* shell in a manner comparable to that of *Fissurella*. In connection with the superior mantle aperture in *Dentalium*, considerable space is devoted to the discussion of the origin and development of mantle-cavity and cleft. He supports the derivation of Cephalopod arms from Scaphopod cirri by reference to the tentacles of *Nautilus*. Each *Nautilus* tentacle he regards as homologous with a Dibranchiate arm.

Finally, the derivation of Cephalopods from Pteropods is unfavourably criticized. The indecisiveness of the palæontological evidence is noted.

Œsophageal Glands of Octopus.*— M. A. Palliet describes the minute structure of the large glands found in the upper portion of the alimentary canal of Cephalopods. Sections of the glands which resemble bunches of grapes in appearance, exhibit the following structure. About a fifth of the whole mass is occupied by interstitial tissue which includes round cells in an amorphous matrix, fusiform cells imbedded in fibrillar substance, capillaries, nerve-fibres, and sheaths round the ducts. The excretory canals are very abundant, their lining cells are opaque and striated, while those of the secreting ducts are clear or dark. The gland is not acinose, but is a ramified, digitate tube, comparable for instance to Brunner's glands on the duodenum of the dog.

Some of the culs-de-sac are, at their base, filled with very granular, polyhedral cells, which almost close the lumen. Higher up elongated cells occur, without the large granules, but staining darkly with osmic acid. These are probably two states of ferment-producing cells. They occupy the deeper third of the canals. The remaining portion exhibit elongated cup-shaped mucus-cells, not darkened by osmic acid.

The excretory canals exhibit a curious structure. They are lined by a series of opaque balls in a single layer. Each ball is surrounded by a clear zone, and the whole is imbedded in the opaque substance which lines the canals. The whole band has a striated appearance as in the excretory canals of the salivary glands. The balls themselves are striated. In the clear zone round each ball there is a nucleus, surrounded by a zone of clear protoplasm. A comparison with Nussbaum's researches suggests that the central striated portion

* Journ. de l'Anat. et de la Physiol., xxii. (1886) pp. 398-401 (1 pl.).

corresponds to that which is eliminated in the gastric glands of the salamander. The gland has probably a mixed function of secreting both mucus and ferment. The octopus has no other gastric glands which could furnish digestive juices.

Structure of Pterotrachea.*—Dr. R. Warlomont communicates the results of some studies on Heteropod structure as illustrated by several species of *Pterotrachea*.

I. *General distribution of integument and musculature.*—The body consists essentially of a long tube of very firm gelatinous substance, clothed by a very delicate epidermis, and traversed in the middle by a muscular layer. The two gelatinous layers, internal and external, contain a great number of large round cells with large nuclei. The cavity inclosed by the muscular tube and by the internal gelatinous layer is traversed by the digestive tube. Beyond the anal extremity the body is prolonged to form the *tail*. In this the muscular layer is not represented except by four isolated connecting bands. In the gelatinous tissue the round cells are replaced by stellate forms. The fin is a dorsal expansion or diverticulum of the muscular wall, and consists of two muscular plates with longitudinal and oblique fibres.

II. *The nervous system and the ciliated organ.*—Dr. Warlomont describes the four groups of ganglia:—(1) the three pairs of cerebrals, (2) the one-paired pharyngeal, (3) the one-paired pedal, (4) the two unpaired visceral ganglia. The distribution of the numerous nerves is then noted. In regard to the interesting nerve-terminations in the skin no new information is communicated. The peculiar ciliated organ consists of two portions, an internal nervous mass continuous with the nerve from the visceral ganglion, and an external epithelial portion distinctly separable from the former. The nervous band consists of a central fibrous portion and of peripheral ganglion cells, and the whole mass is surrounded by a special envelope. The epithelial portion exhibits (1) a thick median mass of large stratified cells, with a deep central depression, marking the region where the nerve-fibres enter, and (2) a lateral elevation of long ciliated cells.

III. *Visceral region.*—The muscular layer of the body ends in a cul-de-sac where the tail is given off. This cul-de-sac is kept in position by two strands. Behind this and a little further up the muscular bands which run out into the tail are united in a common trunk. The cul-de-sac lies above a special muscular pouch—the pericardium—which is quite distinct from the peri-intestinal cavity, and is here very much restricted in its development. The pallial cavity is then described in detail, as also the branchiæ round the ciliated organ, and the general disposition of the visceral sac or "nucleus." As to the digestive tube, the œsophageal portion, which exhibits the usual characters, is enormously extended, occupying the whole length of the body, while the intestine and liver are much reduced.

* Journ. de l'Anat. et de la Physiol., xxii. (1886) pp. 331–50 (1 pl.).

IV. The last portion of the paper contains a description of an aberrant type of Heteropod, which the author would refer to the Carinaria group.

Symmetry of Gasteropoda.* — Prof. O. Bütschli proposes an improvement on Spengel's theory of the derivation of the chiastoneural arrangement in Gasteropods. Like Spengel, he derives the modern forms from a primitive Placophore-like type. In such a form there would be of course two cerebral and two sub-œsophageal ganglia. Besides these in the Chitons there are the two branchiovisceral strands which run along the whole body, and unite posteriorly above the intestine. These Spengel compares with the visceral commissures of Gasteropods which unite the pleuropedals with the so-called abdominal ganglion. The latter gives off nerves to kidney, reproductive organs, heart, &c., and lies ventral to the intestine, like the visceral ganglion of Lamellibranchs. The visceral commissure of Gasteropods is thus *ventral*, while the branchial visceral strands of *Chitons* unite *dorsally*. Spengel acknowledged, but did not get rid of the difficulty; Bütschli gets over it by denying the postulated homology of the nerves. In the *Placophora* the nerves in question are essentially pallial, and are not homologous with the visceral commissures which do not supply the mantle, but with two distinct pallials which, sometimes at least, meet dorsally. In *Chitons* the visceral commissure is thus not represented by well-differentiated or distinct branches, but only hinted at by the stomachic nerves, &c. Gradually, however, it may be supposed that visceral commissure and mantle-nerve were distinctly separated.

From such a primitive form, then, Spengel supposed that the Prosobranchiate chiastoneural arrangement resulted by the whole complex of organs to right and left and in front of the anus, rotating for 180° round the latter. Bütschli allows that the rotation has occurred, but differs from Spengel as to its mode. He objects to Spengel's account since it seems to him to overlook the fact that the anus and branchiæ must retain their characteristic position on the pallial groove. The asymmetry of *Prosobranchiata*, &c., concerns not only the nervous system and the organs generally, but also the intestine and the anus. The anus has been shunted forward, in the pallial groove, on the right side. The formation of a shell implied the more anterior position of the anus, and it is this intestinal asymmetry which has conditioned that of the other organs. At a certain stage of development, when the anus is still at the posterior end, a narrow dorso-ventral zone on the right side between anus and mouth ceases to grow, the corresponding left region continues, and the longer the disproportionate growth continues, the more is the anus shunted towards the head. The zone of suppressed growth extends a little beyond the anus to the left side, and thus the left gill follows the anus. This disproportion is confined to an annular zone of the pallial groove; foot, mantle, &c., continue growing equally, and an external symmetry is preserved.

The consequences of this disproportionate growth on the intestine

* Morphol. Jahrb., xii. (1886) pp. 202–22 (2 pls.).

and other organs is then sketched in a series of very lucid diagrams which make this origin of asymmetry readily intelligible. The theory is compared with the author's investigation of the development of *Paludina*, and the changes in the lie of the organs are shown in different colours on a diagram composed from three superposed stages. Lastly, the independent torsion of the visceral sac is discussed.

Innervation of Heart in Helix.*—Signor A. Trambusti has studied the innervation of the heart in *Helix pomatia*. In his technique he made use of gold chloride and arsenic acid (Golgi's method). The nerves of the cardiac muscles are formed of fibres without medulla, and invested in a nucleated sheath. They form two trunks, the larger of which gives off several filaments, which after forming an auricular plexus, unite in large bundles and pass into the ventricle, while the smaller branch which traverses the auricle, gives off two or three branches, forms a small ganglion of seven or eight cells, and then ramifies in the ventricle. The author did not observe any motor plate; "the nerve-fibres become associated with the muscle-fibres without undergoing modifications of form, and accompany the former along their whole length."

Nuclear Fusion in Cleavage Spheres.†—Dr. O. Zacharias reports that in the ova of *Limnæus auricularis* he has been able to observe, as a pathological phenomena, the fusion of the first two segments of a dividing egg; it was most marked when the egg was only surrounded with a little water, and may be due therefore to a want of oxygen. In the cases first observed, the nucleus remained passive, but in a later specimen Dr. Zacharias saw the nuclei approach one another.

Nervous System and Sensory Epithelium of Cardium.‡—Herr K. Drost has investigated the nervous system and sensory epithelium of *Cardium edule*, and communicates further some notes on the histology of mantle and siphon.

I. *The nervous system* has been carefully described by Duvernoy, whose results Herr Drost has confirmed and amplified. The details are of no special interest.

II. *The sensory epithelium.—Cardium edule* exhibits four different kinds of sensory epithelium. Two of these are localized, and two are expanded on the surface of the body. In the first place there is a pigmented epithelium, sensitive to light, occurring on the convexity below the cirrus points. A second kind is exhibited in the combination of supporting, and extremely long-haired sensory cells, which forms the organ imbedded in a depression of the cirrus point. Thirdly, normal penicillate cells occur with very short hairs, and finally broad brush-cells with longer hairs, projecting through the cuticular warts. The associated innervation is very complex.

III. *Histology of mantle and siphons.*—After noting the character

* Rev. Internat. Med. e Chir., ii., No. 12 (1 pl.). Cf. Rev. Ital. Sci. Nat., ii. (1886) pp. 54–5.

† Zool. Anzeig., ix. (1886) pp. 400–3.

‡ Morphol. Jahrb., xii. (1886) pp. 163–201 (1 pl.).

of the epithelium, the so-called "protoplasmic processes" of the cells, the distribution of cilia, the formation of the epicuticula, &c., Herr Drost discusses somewhat minutely the relation of certain dark brown spots at the upper end of both siphons. These turned out to be bottle-like glands of pigmented cells, variously divided, and opening by a minute efferent duct. Two other forms of glands occur. The bottle-shaped mucous glands, described by Flemming in *Mytilus*, are distributed all over the mantle margin, but in especial abundance under the ciliated epithelium. A third form occurs on the mantle margin and on the siphons on the external surface, but only in the zone covered by the young epicuticula or the shell. All these types are carefully described. Below the epithelium a distinct hyaline layer is everywhere demonstrable, of obvious importance as a basis of attachment for the muscles. Below the epithelium in the siphons there is a thin layer of fine circular muscles; this is succeeded by a very thin sheath of delicate longitudinal muscles. The separation of the subepithelial from the others does not always occur. In the cirri and in the mantle the connective tissue and radial muscles are continuous with the epithelium. The greater portion of the siphon wall is formed of the main muscular masses, which consist of longitudinal and circular fibres developed in variable proportion. But besides these, other muscles connect the outer and inner surfaces of the siphon wall, and lie at right angles to both the two systems just mentioned. The latter occur isolated or in small bundles at approximately regular intervals. The disposition of these three systems in the mantle is then described.

The memoir closes with a discussion of the controversy between Flemming and Kollmann as to the nature of the connective tissue. Herr Drost's results confirm Flemming's opinion. He maintains the cellular nature of Langer's vesicles. The fibrous tissue near the optic ganglion is finally discussed, and its probable derivation from modified mucus-cells is maintained.

Molluscoida.

a. Tunicata.

Structure of Amaræcium torquatum.* — M. C. Maurice has studied the structure of the above-named compound Ascidian, and has established a number of new facts in regard to the anatomy of such forms.

I. *The branchial system.*—The branchia consists of thirteen series of stigmata, and exhibits three main peculiarities. (*a*) The transverse sinuses which separate the stigmata are fused directly with the internal tunic on each side of the endostyle, over about a third of their circumference; elsewhere numerous trabeculæ bind them to the tunic. From this it follows that the peribranchial cavity is subdivided into a series of secondary cavities, open towards the cloaca, and closed by culs-de-sac towards the endostyle. (*b*) Along each of the transverse sinuses, the branchial wall forms a continuous fold, hanging into the

* Comptes Rendus, ciii. (1886) pp. 434–6.

branchial cavity. These interserial plates almost divide the branchial cavity into a series of secondary cavities. They are not even interrupted on the dorsal surface, but are directly continuous with the median dorsal languets, which are to be regarded as appendages of the "interserial plates." (*c*) Inside each of the transverse sinuses and interserial plates a pair of muscles extend, side by side, throughout their entire length. These extend all round the branchiæ, except, of course, at the level of the endostyle, where there are no transverse sinuses. They are united by numerous anastomoses to the longitudinal muscles of the internal tunic.

The retropharyngeal tract does not form a gutter; for a large portion of its course it appears merely as a ciliated ridge projecting into the branchial cavity. Only the right margin of the furrow is developed; the ridge is, on the one side, continuous with the two lips of the endostyle, and loses itself on the other side in the œsophagus. The cells round the stigmata are elongated in the direction of the length of the latter. They are arranged in transverse rows of six cells. Each bears a projecting ridge with 11–15 cilia.

II. *Nervous system.*—The *ganglion* consists of a fibrillar mass with several series of irregularly disposed, peripheral ganglion cells. The *visceral cord* has a similar structure. It is prolonged between the branchial and cloacal epithelium towards the visceral mass. It is surrounded by large blood-spaces, and accompanied, throughout its entire length, by lateral muscle-bundles. The *hypoganglionic gland* consists of a mass of cells, markedly degenerating towards the centre. The discharge is got rid of by the aid of the vibratile organ, and passes off between the tentacular crown and the external lip of the pericoronal furrow. Posteriorly, the gland is continued into a canal, which loses itself in connection with the visceral nerve-cord. At an early stage the excretory duct of the as yet unformed gland is continuous with the lumen of the visceral cord, then also a tube.

III. *Muscular system.*—Apart from the muscles round the two siphons, only longitudinal muscles occur in the tunic. These are all lateral, none are in reality median. Each bundle ends near the extremity of the post-abdomen in a knob-like projection. The muscles consist of homogeneous, unstriated fibrils surrounded by a fine sarcolemma, and including between them masses of nucleated protoplasm.

Polyclinæ.*—M. Lahille considers that the great polymorphism of the genus *Sidnyum* has led various authors to rename species of this genus as belonging to other genera: e. g. *Circinalium concrescens* is really *S. turbinatum*. He divides the Polyclinæ into two families: the Polyclinidæ, and the Aplididæ, the characteristics of which are given. The first family are remarkable amongst other points for the "reproductive appendix," the post-abdomen of other authors. It contains a flattened cavity, the "endodermic tube," bifurcated at each end. The cavity is originally a prolongation of the branchial chamber, and is placed ventrally. This endodermic tube

* Comptes Rendus, ciii. (1886) pp. 485–7.

separates a dorsal from a ventral cavity, in the former of which lie the genital glands; the ovary in front of the testis. As in other Ascidians six regions can be distinguished in the alimentary tract. The vibratile organ is only the expanded extremity of the larval nerve-cord.

Simple Ascidians.*—M. L. Roule who in former memoirs dealt with the organization and distribution of the family Phallusiadæ, of which *Ciona intestinalis* was taken as the simplest type, and the variations in the other genera compared with it, in the present paper describes the family of the Cynthiadæ, the characters of which are given as follows:—The tunic is tough and opaque, and frequently presenting a colour of its own, not including vacuolated cells such as those found in the Phallusiadæ. The siphonal apertures have a quadrangular form when moderately open, and when shut have the appearance of a cross. The branchia (pharynx) is provided with large folds extending from one end to the other, but these folds are not traversed by cross folds so as to form distinct "infundibula" as in the Molgulidæ.

In some points the Cynthiadæ form a transition between the more simple Phallusiadæ and the more complex Molgulidæ; e g. the tentacles are in some forms merely simple filaments, as in the first-named family; whereas, in others, they carry lateral and even branched expansions, leading to the condition found in the Molgulidæ.

Again, the dorsal groove is present in some, though more reduced than in the Phallusiadæ; but in others it is absent, as in the Molgulidæ.

If the peribranchial cavity be traced through a series of forms, it shows a progression from a simpler (as in *Ciona* and *Rhopalona*) to a more complex arrangement in the remaining genera of the Phallusiadæ, the Cynthiadæ, and the Molgulidæ. In the succeeding chapters the various organs are described in detail and compared in various forms; at the end of each chapter a *résumé* is given, which is here reproduced.

The body-wall of the family shows the same general disposition and relation to the "branchia" as in the Phallusiadæ.

The epidermis is formed of a single layer of columnar cells, the height of which exceeds the breadth. The dermis consists of connective tissue limiting numerous blood-sinuses, and including bundles of smooth muscular fibres.

The siphons resemble those of Phallusiadæ; the fold of the tunic lining them is armed with small chitinous teeth.

The coronal tentacles are simple in *Polycarpa* and *Styela*, and are slightly branched in *Cynthia* and *Microcosmus*.

The "dermal prolongations" or vessels of the tunic are similar to those of the Phallusiadæ. The branchia of *Eugyriopsis*, one of the Molgulidæ, is described, and the structure of this organ in Cynthiadæ compared with it on the one hand, and with the Phallusiadæ on the other; hence it is inferred that in the Cynthiadæ the branchia is more or less intermediate between these families.

The "pericoronal groove" and "ventral raphe" resemble in general these organs in the Phallusiadæ.

* Ann. Sci. Nat.—Zool., xx. (1886) pp. 1–124 (4 pls.).

The dorsal raphe in the genus *Cynthia*, as in *Ciona* and *Rhopalona*, is formed of a series of delicate *languettes*, and a dorsal groove is present; but in the genera *Microcosmus*, *Styela*, and *Polycarpa* this groove is absent, and the raphe is formed of a membrane as in most of the Phallusiadæ.

The form of the "posterior raphe," which is always in part dorsal in position, varies in the different genera.

The alimentary tract is placed on the left side of the animal, as in the genus *Ascidia*, and is united to the dermis either directly, or, in *Polycarpa*, by means of membrane.

The entrance to the œsophagus from the pharynx (branchia) is surrounded by a smooth "œsophageal area," which varies characteristically in different genera; the dorsal raphe passes along the left side of the area; the posterior raphe comes up to meet it; the wall of the œsophagus is traversed by four or five deep furrows. The wall of the stomach is similarly thrown into numerous folds, as in the Phallusiadæ. *Microcosmus* is exceptional, in that the alimentary tract, with the exception of the rectum, is embedded in the large genital gland.

The structure of the stomach in the various genera is given in detail, both macroscopically and histologically. The cells which line the grooves contain numerous yellowish-green granules, probably indicating a biliary secretion.

The intestine has a lining of cylindrical epithelium containing goblet-shaped mucous cells. This is surrounded by the epithelium (ectoderm) of the peribranchial cavity, as is also the stomach. There is a typhlosole in *Styela* and *Polycarpa*.

The nervous system resembles that found in Ascidians generally.

There is no large cœlom in the adult simple Ascidians, though present in the larva. The in-pushed peribranchial cavity obliterates it, the outer wall of which becomes pushed against the body-wall, and the inner wall against the intestinal and branchial wall. However, the pericardium and the cavity in which the renal and genital organs lie, are representatives and remnants of the once more extensive cœlom.

The circulatory system, as in other Ascidians, consists of a very complex lacunar network, including in its course certain sinuses, in which the course of the blood cannot be regulated, except in the walls of the "branchia," where the crossing of the sinuses at right angles leads to a certain amount of regularity. This lacunar organization is the cause of the alternation of the direction of the blood. The wall of the heart varies in different genera. Excepting the heart, the blood-vessels have no proper wall.

The elements of the blood resemble those found in the connective tissue, and are of two kinds: one sort are analogues to lymph-corpuscles; the second are derived from the first, by degeneration, and are formed of small concretions or granules.

β. Polyzoa.

Development of Polyzoa.*—In the study of the development of *Bugula calathus* Norm. Dr. W. J. Vigelius has made an important contribution to our still incomplete knowledge of the ontogeny of the Polyzoa. After discussing the specific characters of *B. calathus* and the technique employed in his investigation, Dr. Vigelius passes to consider—

The maturation of the ovum. It seems probable that the ovary is a product of the mesenchymatous parenchyma, arising as a local proliferation of indifferent cells. It is attached or appressed to the parietal layer of the neural wall of the sexual individual. A few incipient ova (described in detail) are surrounded by small flattened follicular cells. A struggle for existence begins, and the potential ova are reduced to one, or rarely to two. The ovary becomes in the meantime free; a follicular remnant probably remains to form the rudiment of a new ovary. The egg becoming independent wanders through the body-cavity to the ovicell; it is then likely that fertilization occurs.

The brood-capsule arises somewhat later than the ovary in the form of two diverticula from the free distal wall of the sexual individual. The growth of these two sacs, and the manner in which they unite are carefully described. The interior is lined by a continuation of the parietal layer of the parenchyma. In one region, where the embryo is afterwards borne, a layer of peculiar cylindrical cells is developed. They seem to be aided by wandering cellular elements, probably from the mesenchym, which apparently discharge an important formative function. The elongated parenchymal cells which form two bundles of ovicell muscles are then described.

The segmentation is alecithal. The first plane of division lies in the short axis and cuts the animal and vegetative pole. The second is also meridional in the long axis of the ovum, crossing the former. The third is an equatorial plane, at right angles to the two previous. The differences in size between the segments are neither very marked nor yet constant. In the stage with 8 segments a small but distinct blastocœl can be detected. The 16 stage arises as the result of a double division in two planes, which lie on either side of, and parallel to the first meridional division; and that with 32 results from a division similarly related to the second meridional plane. The blastosphere is then distinct, and the oral and aboral halves are clearly distinguished. The shape of the young embryo varies considerably, now like a biconvex lens and again ellipsoidal.

The formation of the germinal layers. In sections of embryo at the last-mentioned stage, four cells are seen within the blastocœl, closely adjacent to the outer cells, about the centre of the oral surface. These form the rudiment of the *endoderm*, and Vigelius gives a number of reasons which make it probable that they are intruded in consequence of an epibole. They gradually increase in number, and form a complex of cells completely filling the blastocœl. This mass remains during the further embryonic development very passive, and represents,

* MT. Zool. Stat. Neapel, vi. (1886) pp. 499–541 (2 pls.).

according to the author, not only endoderm but *mesoderm*, though Barrois asserts the distinct definition of the mesoderm as two lateral "cordons" constricted off from the young endoderm. Cavities are observed in the cell-complex above referred to, and these represent the primitive *calom*, and are regarded by Vigelius as remnants of the blastocœl which have enlarged and become modified during the growth of the embryo.

Meanwhile the ectoderm cells in the oral and aboral halves have multiplied. An annular thickening is observed in the equatorial plane, composed of two rows of cells, one belonging to each half. From the aboral ring of cells the ciliated *corona* appears to be formed. Two ectodermic invaginations are formed on the oral surface. One of these, lined with high cylindrical cells, is the commencement of the *suctorial pit*, which serves for the attachment of the larva. Its opening lies a little behind the oral pole. The invagination increases in size and becomes sac-shaped, occupying a large part of the body. The second invagination has been repeatedly described as the oral groove ("Mundfurche"). It has, however, nothing to do with the mouth, and is more fitly described as the *anterior ectodermic groove*. At the aboral pole, a multiplication of ectoderm cells forms a third organ, very variously designated, *the retractile disc*. It intrudes for some distance into the interior of the embryo, as a thick flattened disc. Round it a circular invagination of the ectoderm takes place, forming an oblique groove. The cells at its blind end proliferate and form a peculiar *pear-shaped organ*. This Vigelius describes in some detail, and regards as a *gland*, which has possibly a function in connection with the formation of the tegumentary skeleton. All these structures increase in size and are slightly modified. Shortly before escaping, the embryo undergoes modifications of form very different from those of the larva.

The external characters of the *larva* are then described. The degeneration of the long coronal cells and similar changes are noted, and lastly the metamorphoses of the larva. The author's results, of which a completion is promised, support Barrois' conclusion that the development is in no way a metagenesis, but a true metamorphosis in which the organs of the sessile adult are directly developed from definite organs present in the larva.

Metamorphosis of Fresh-water Polyzoa.*—Herr A. Ostroumoff finds that the cells of the ectoderm at the hinder pole of the larva are much higher than those on the rest of the surface, and he is inclined therefore to regard this area as a functionless rudiment of the sucker, which is found in all marine Ectoproctous Bryozoa.

The whole course of metamorphosis in *Alcyonella* may be divided into two stages; in the first, which is common to all Ectoprocta, the mantle bends over on the basal side; in the second, which is found in fresh-water forms only, the basal side with the edges of the mantle are invaginated, so that the ascending portion of the mantle-cavity forms a canal, the walls of which soon fuse, and from which the body-wall of the primary zoœcium is alone developed.

* Zool. Anzeig., ix. (1886) pp. 547–8.

Arthropoda.

Maturation of the Arthropod Ovum.*—Herr F. Stuhlmann contributes a welcome investigation of the phenomena of maturation in the but little known Arthropod ova.

Some of the uniform nuclei of the germinal layer are seen to differentiate towards ova. At an early stage they can be detected in stained preparations. They exhibit a central and a number of peripheral chromatin bodies, but the latter disappear. No passage of chromatin bodies from the nucleus was observed. At an early stage the germinal vesicle, formed as above, wanders to the periphery, seems to get flattened up against the follicular epithelium, and very often loses its nucleolus. In many insect ova a number of balls resembling the nucleus in their constitution, seemed to be extruded from the germinal vesicle on the side next the follicular epithelium.

The occurrence of polar globules is discussed; their apparent absence in large ova rich in yolk; their presence in small ova, like those of *Moina* and *Polyphemus*. The expulsion of the above globules of maturation occurs at a very early stage, before the egg has attained half its size. After their expulsion the germinal vesicle is drawn inwards and eludes observation. In Aphides and Cecidomyia larvæ it remains visible. It seems to become amœboid in the large ova richly equipped with yolk, but is probably in most cases distributed in the protoplasm.

As to the so-called yolk-nuclei, they do not, according to Stuhlmann, arise from the germinal vesicle. They appear near the germinal vesicle and move to the periphery or to the superior pole, or remain diffuse. They may unite further into a single large mass at the posterior pole. They are simply yolk-concretions of a nutritive character, afterwards absorbed.

Terminations of Motor Nerves in Arthropod Muscle.†—As the result of his investigation of the terminations of the motor nerves in the striped muscle of Arthropods, Signor U. Gabbi comes to the following general conclusions:—

1. In *Musca*, *Libellula*, *Oryctes*, *Silpha*, &c., the primitive muscle-bundle presents a close structural resemblance to the muscular bundle in Vertebrates.

2. In the Arthropods mentioned the ensheathing envelope of the motor nerve, which enters into close relations with the primitive muscle-bundle, is continued into the sarcolemma, which forms the investment of the so-called elevation of Doyère.

3. The axial cylinder, penetrating the apex of the elevation of Doyère, increases slightly and divides, except in *Musca*, into two branches ending at the base of the cone. In *Musca* the two primitive branches undergo a further bifurcation. In all the Arthropods examined the motor termination is situated below the sarcolemma.

* Biol. Centralbl., vi. (1886) pp. 397–402. Ber. Freib. Naturf. Ges., i. (1886).

† Bull. Soc. Entom. Ital., xviii. (1886) pp. 310-32 (2 pls.).

4. The granular material which fills the cone, or the non-nervous portion of the motor termination, exhibits nuclei varying in form and number, in all the Arthropods noted with the exception of *Geophilus*.

5. The branches resulting from the terminal bifurcation of the axis never exhibit in their course strictly associated nuclei.

6. With the exception of *Blatta*, in all the other Arthropods examined, there seems to be only one elevation of Doyère for each muscle-bundle.

7. In *Blatta* and *Oryctes* the motor nerve passes through a nerve-cell before joining the muscle-bundle. In all the species examined the nerve is frequently accompanied by a tracheal filament.

Dermal Sensory Organs of Arthropoda.*—Prof. F. Leydig reminds us that he has already expressed the opinion that all such structures as tactile setæ, olfactory bulbs, and auditory hairs of Arthropods are modifications of the ordinary hairs and setæ. The question naturally arises, what are the contents of the ordinary hair-like processes of the integument? Sting-hairs, such as those on the larva of *Saturnia*, have a wall, the structure of which is similar to that of the dermal carapace. There is a homogeneous cuticle, a cellular matrix, and a contained blood-fluid. Where the hair is articulated to the integument the lumen is either simply filled with clear fluid, or it is spanned over by plexuses, in the meshes of which the fluid is contained. The fluid contents appear to be of the nature of a secretion. In the larva of *Bombyx rubi* there are multicellular pouches, and in that of *Dasychira pudibunda* unicellular glands. The cuticular wall of the hair may be derived from the matrix cell; the fluid within represents the hyaloplasm of the cell-substance, while the plexus is derived from the spongioplasm.

The tactile setæ are distinguished by being the support of the terminal ganglionic cell of the nerves, and it is really in this point only that they differ structurally from ordinary setæ. The cylindrical or conical bodies which have had an olfactory function assigned to them, have a more special character. The extent of the cuticular investment varies with an aquatic or terrestrial habit, for in insects and Myriopods the chitinous coat is of the same thickness along the whole of the organ, while in the Crustacea it is much thicker at the base than it is at the tip. Further, the free end of the bulb has an orifice, and the contained substance is a pale homogeneous substance which seems to be a naked axis-cylinder.

The auditory rod is an enlargement of a nerve-tube. It has an investment which is at first delicate, but which gradually thickens, and is the cause of the dark margin. The clear homogeneous contents correspond to the nervous hyaloplasma.

Tactile setæ may be scattered over the surface of the body of an Arthropod, and are sometimes collected at definite points. These are those which an observer of the living animal is inclined to regard as gustatory organs; indeed, tactile setæ and gustatory hairs are not to be

* Zool. Anzeig., ix. (1886) pp. 284–91, 308–14.

sharply distinguished from one another. The relation of gustatory to olfactory organs is about the same, and there are all kinds of intermediate stages between them. Much the same is true also of auditory hairs.

The ganglia which supply the sense-organs may become doubled. The morphological connection between tactile setæ and glandular hairs indicates a close connection between nerve-activity and the secretion of material. In *Anguis fragilis*, he reminds us, a strong and peculiar smell may be sometimes noticed, although this reptile has no dermal glands. Here we are led to the conclusion that the smell must arise from the goblet organs of the skin, and therefore from the nervous end-organs.

Development of various kinds of Ocelli.*—Herr J. Carrière states that some of the scorpions have true rudimentary ocelli; in *Chelifer* the eyes are colourless, there is a thick chitinous lens, and underneath it are two layers of cells, one lenticular and one retinal, but there is no pigment, and there are no rods. The irregularity in appearance of these organs in various genera speaks to their being organs which are disappearing.

The Ephemeridæ have true eyes, but they differ much from the typical ocelli of spiders, flies, or bees; above the peculiar layer of retinal cells there is a large spherical lens formed of clear chorda-like cells, and the lens is most like that of the eye of *Pecten*. The cornea lies like a watchglass above the lens, and the whole organ has very much the form of the eye of a raptorial bird.

The author has been able to study the development of the ocelli of the Chrysididæ and Ichneumonidæ, which he thus describes: the cells of the hypodermis elongate and become divided into two layers; at the periphery of the rudiment there is formed on one side a pouch-like invagination, which is directed obliquely downwards, and both layers take part in this; the cells of the outer layer are those that form the lens, the inner the retina. The pouch grows in under the centre of the lens-like rudiment, while the cells which take no part in the invagination elongate and form a ridge above the pouch, and takes part in forming the corneal lens. As the pouch widens the cells of the ridge pass to the sides. In the Vespidæ and Diptera the process is somewhat modified, the ridge disappearing more or less. Reference is made to the recently published observations of Mr. Locy on the development of *Agelena nævia*, and priority is allowed him as to the discovery of the primary thickening and the invagination, but Herr Carrière is of opinion that the later stages of the development of the spider's eye resemble what he has seen himself, or that, in other words, there is no constriction of the invaginated pouch, such as has been described by Mr. Locy.

* Zool. Anzeig., ix. (1886) pp. 496–500.

a. Insecta.

Regularity of Sperm-movements.*—Following up a previous communication,† Herr J. Dewitz has communicated the results of his further studies on the movements of spermatozoa in finding their way into the ovum. The form investigated was *Periplaneta* (*Blatta*) *orientalis*.

a. The Spermatozoon. The sperms are seen to be attracted to surfaces, on which they move in circular courses. This was demonstrated in very varied ways with sperms kept in 0·8–0·9 per cent. salt solution. In viscid fluids the course was irregular. The direction of motion is always (on the attracting surface) the reverse of that of the hands of a watch. Various interesting modifications of the principal observation are noted.

b. The Ovum. The surface of the ovum, the disposition of the micropyles, &c., are described. The attraction of the sperms to the surface, and the motion in ever slightly varying circles, must obviously secure a speedy entrance into a micropyle. This was successfully verified on hardened empty egg-membranes. Herr Dewitz notes that in many cases what has been referred to as a gelatinous, viscid membrane is not really so, and thus offers no hindrance to the movement of the sperms.

c. In the third division of his memoir Herr Dewitz describes the anatomical relations of *fertilization*, and shows how they harmonize with what he has observed as to the regular motion of the sperms.

Blood-tissue of Insects.‡ — H. Ritter von Wielowiejski finds various kinds of blood-cells in the cœlom of insects. The so-called fat-cells have a tendency to unite into larger complexes; with the exception of some examples of *Apis* and *Melophagus*, where there were binucleate, and the imagines of *Musca*, where there were multinucleate cells, there were only uninucleate cells to be seen. The contents are fluid and fatty, but in a few cases contained albuminous bodies (*Corethra*), or uric acid concretions (Lampyridæ). The second kind of cell is, in consequence of its colour, called the "œnocyth"; these were found arranged in groups, or were very small, or formed rows, or plexiform plates, or larger complexes or plates. The third class is formed by the pericardial cells; these differ so strikingly in the different groups of insects, that it is scarcely possible to give a histological definition of them. Other cells are less easy to find, but may belong to special groups.

The author is inclined to refer the blood-cells to the secondary endoderm; as to their function, all that seems certain is that it is not of a respiratory significance.

Habits of some Guests of Ants.§ — Herr E. Wasmann groups the guests of ants under the three heads of those which stand in

* Pflüger's Arch. f. d. gesammt. Physiol., xxxviii. (1886) pp. 358–85 (1 pl.).

† See this Journal, *ante*, p. 43.

‡ Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 512–36.

§ Deutsche Entomol. Zeitschr., xxx. (1886). See Naturforscher, xix. (1886) pp. 269–70.

friendly relations with them, such as some of the Aphides; those which act as scavengers, like the dipterous *Dinarda*, *Stenus*, and *Homalota*; and thirdly, those which are not guests but robbers, as are some species of Coleoptera.

Œsophagus of the Honey Bee.*—If the honey stomach of a bee be examined, there will be found on its under part and a little to one side, a small body about half the size of a poppy seed, and having a yellowish-red reflex; this organ is recognized by Pastor Schönfeld as a second or internal mouth, and in his opinion it is the possession of this organ which makes the bee what it is, namely, a honey bee. For this organ alone enables it to store up honey in its honey stomach, and then to pour it into the cells; it gives the power of making wax and of withstanding the winter's cold.

If this organ, taken from the freshly killed bee, be placed under the Microscope, four lips round its top will be seen opening and shutting in rapid motion. The yellowish-red appearance proceeds from the intima into the structure of which much chitin enters; this renders the organ, especially about the base of the lips, so hard that it creaks under the knife or needle. If now the intima be cut through, after separating it from its attachments, and spread out, it presents the appearance given in fig. 200. Just below the junction of each adjacent pair of lips is an opening, and on the smooth sharp lip edges of the intima is a border or selvage beset with hairs, the points of which are directed backwards. This selvage is easily detached with a needle from the intima.

Fig. 200.

If a longitudinal section be made through the middle of the honey stomach and the upper part of the chyle stomach, there will be found numerous bundles of longitudinal muscular fibres, succeeded by bundles of circularly disposed fibres which surround the connection between the honey and chyle stomachs, or the neck of the organ. Upon the circular muscles lie the propria and a very delicate transition membrane. The neck of the organ is lengthened in such a manner that it projects free into the cavity of the chyle stomach, forming a kind of fold or prolongation, so that the neck can be lengthened or shortened. From a consideration of the anatomical construction of the organ, the author arrives at the conclusion that the valves are not a mere passive mechanically acting apparatus. Great numbers of the muscles are striated, and therefore must be in all probability under the direct control of the insect, which has a voluntary power over both the honey and chyle stomachs. The lips are kept open when the animal desires to take in either honey or pollen, and *vice versâ*. For these reasons the author determines the organ to be an œsophagus, and so calls it. He then goes on to remark the mechanism of the duplication or prolongation backwards of the stomach. If the honey stomach be full of pollen no

* Arch. f. Anat. u. Physiol. (Physiol. Abth.), 1886, pp. 451–8 (1 fig.).

difficulty is experienced in manipulating it, but if the supply of pollen-grains be small, then the contractility of the circular fibres is called into request. These act by diminishing the calibre of the tube, and consequently bring the pollen-grains within control of the lips. The interspace between the chyle and honey stomachs is stated (on account of its formation as a diverticulum and from containing two layers of muscle-fibres) to be intended to prevent the rupture of the organ during the manipulation of honey.

In this honey stomach the author sees a store-chamber or reservoir of food, which will maintain the animal against hunger and cold for many days, and points out in copious diction the value of this arrangement in winter.

The author concludes by saying, that if the hand of God turned out the bee at the Creation, then the honey bee and its œsophagus ("Magenmund") are as they were at the beginning; if, however, the Darwinian theory be preferred, then in the course of an endless number of years this œsophagus has developed from a folding or constriction of the œsophagus proper ("Speisröhre").

Vesicating Insects.*—M. H. Beauregard continues his monograph on the Meloideæ, discussing in the present contribution the structure of the digestive tube.

A. *External form.*—The external characters of the three great divisions are first described. The *œsophagus*, with thickened and externally ridged walls, exhibits a dilated crop in those forms which do not feed exclusively on pollen. The *chylific portion*, separated from the former by the cardiac valve, attains a proportionately large size. It is externally marked by annular thickenings of the mucosa. The *intestine*, separated from the latter by the pyloric valve, is short in those forms which feed principally on pollen, but long and looped in those which live on leaves.

B. *Structure.* (*a*) *Œsophagus.*—Starting with a Cantharid type, M. Beauregard describes the histology of the three œsophageal layers —the chitinous cuticle, the internal longitudinal, and the external circular muscles. Outside the latter the surface of the œsophagus is traversed by fine tracheæ enveloped in a mass of irregularly polyhedral adipose cells, disposed in a hyaline matrix. There is no hypodermic layer between the cuticle and the internal muscular layer. There is no structure which could be interpreted as of the nature of a salivary gland. The labrum exhibits unicellular glands both on its superior and inferior surface. The *internal muscular layer* consists of striated longitudinal muscles disposed side by side in a kind of membrane. The *external muscular layers* include two or three planes of superposed circular fibres. The *cuticle* is a chitinous transparent layer, raised internally in numerous hair-like prolongations, which are regularly disposed in rows. The ventral region is free from these processes. Three projecting folds form two parallel grooves with transverse linear thickenings. Lastly, the valves formed by a prolongation of the œsophagus into the chylific portion, are

* Journ. de l'Anat. et de la Physiol., xxii. (1886) pp. 242–84 (4 pls.).

described in detail. The modifications of these structures are described in six forms.

b. Chylific portion.—The wall of the chylific portion consists of five layers:—(1) cuticle, (2) epithelium, (3) connective and follicular, (4) muscular, (5) serous layer. The three former constitute what is usually described as the mucosa, and form the numerous circular folds which are so conspicuous both externally and internally. (1) *The chitinous cuticle* becomes thicker posteriorly, and is penetrated by fine pores at right angles to the subjacent epithelial cells. (2) The *epithelium* consists of a single layer of ordinary cylindrical cells. Between the folds of the mucosa, however, the histological structure is exceedingly like that of an epithelial gland. (3) The *connective and follicular layer* consists of a connective feltwork of intersecting fibres, the meshes of which contain follicles. These follicles consist of ovoid or spherical masses of compacted nuclei. (4) As to *the muscular layers*, the internal is this time circular, the outer longitudinal. The whole chylific region unites the characteristics of a secreting and of an absorbing organ. The folds of the mucosa form true valvulæ conniventes; while the presence of follicles in the connective layer, and the existence of a porous cuticle recall the characters of vertebrate intestines. The structure of the complex pyloric valve is described.

c. The intestine.—In the intestine the cuticle is relatively thick. The well-developed epithelial cells are flattened, cubical, or almost spherical, according to the regions. The connective layer is weakly developed and has no follicles. The muscular layers are disposed as in the œsophagus. The intestine is distinguished histologically into five distinct portions, which are described in detail. The first region exhibits eighteen folds, the second twelve, the third six; this is followed by a smooth portion, and by the terminal sphincter.

d. The Malpighian tubes are next briefly noted. They exhibited no special peculiarities.

e. The adipose body forms a continuous sheath round the intestine. The cells frequently appear to be disposed in cylindrical packets. The component cells are large, and contain large refringent nuclei. They colour rapidly under the influence of osmic acid. The tissue round the œsophagus is looser, and the cells are smaller and more granular.

Larva living without a head.*—M. François notes the curious occurrence of a living larva of *Lampyris noctiluca*, in which the head and a large portion of the prothorax had been removed and replaced by a chitinous scar. There was not the least trace of head or mouth, the digestive tube was normal, the œsophagus recurrent anteriorly, the cervical nervous system drawn slightly backwards. In the normal insect the œsophageal ring is not in the small head, but in the prothorax. M. François gives a full description of the decapitated larva, noting how the accumulated store of reserve nutriment still supplied the necessary capital for life.

* Comptes Rendus, ciii. (1886) pp. 437–8.

Development of Male Generative Organs in Lepidoptera.*—Dr. C. Spichardt has investigated the results of his observations of the development of the male genital organs and efferent ducts in Lepidoptera.

The adult testes are first described, with special reference to *Liparis dispar*. They consist of round bodies, about 1½ mm. in diameter, lying dorsally in the middle line of the fourth abdominal segment, between intestine and dorsal blood-vessel. Three layers ensheath the testis: (*a*) an outer peritoneal envelope of connective tissue, serving for nutrition and protection, and not penetrating between the follicles; (*b*) a muscular sheath, penetrating between the follicles, and present from very early stages; (*c*) the tunica propria, lining the inside of the follicles as a transparent homogeneous membrane, with irregularly scattered nuclei. Within these lie the eight follicles, of a conical shape, with the point directed inwards. The follicles contain spermatozoa at all stages of development, and ripest towards the centre.

The efferent ducts and vesiculæ seminales.—The efferent ducts expand in a funnel-shaped fashion, embracing the testis. Their walls are lined by high cylindrical cells, and a thin membrane forms an external sheath. Variations in several different forms are noted. From the secreting seminal vesicles the ducts continue separate almost to the penis, where they gradually unite.

Ejaculatory duct and penis.—The chitinous cylindrical penis lies below the rectum, and stretches through two segments. From about the middle of the penis the ejaculatory duct arises, uniting with the end of the efferent canals, from which it is markedly distinguished by its muscular walls. Like the penis, it has an ectodermal origin, but it exhibits no chitinous sheath. The erector and adductor musculature is then described.

The development of the testes.—Dr. Spichardt's chief results on this point are thus summarized:—

(1) The generative organs appear at a very early stage. They arise in the "Hautfaserblatt," and are thus probably of mesodermic origin. (2) Between the four primitive cells there are a number (usually four) of nuclei, of doubtful import, from which the germinal rudiment probably arises. (3) The incipient generative organ is ensheathed in a fine membrane with scattered nuclei. (4) The four primitive cells multiply by indirect division, until (5) the four follicles are formed by invagination of the outer sheath. (6) A second envelope, the peritoneal sheath, originates from the fatty body. (7) The nuclei within the cells increase by repeated direct division, from three to five times. (8) From this division there probably originate the small nuclei, which clothe the colony externally, and probably give rise at a subsequent stage to the membrane of the sperm-bundles. (9) Protoplasm gathers round the nuclei, so that cells become separate from one another, and leave a free space in the interior. (10) The nuclei divide into many smaller nuclei, round which the

* Ver. Naturh. Ver. Rheinlands, xliii. (1886) pp. 1–34 (1 pl.).

protoplasm again gathers. (11) From one or from several regions a protoplasmic fluid is excreted. (12) The cells extend longitudinally, and the colony becomes cylindrical. The above-mentioned protoplasmic fluid gathers at the anterior end. (13) The nuclei become elongated and spindle-shaped, they arrange themselves parallel to one another, and end anteriorly in a short, and posteriorly in a longer thread.

The germinal rudiment appears at a very early stage (see 2 above), when the division into four follicles has just commenced. In much older organs the whole series of developmental stages can be traced. The centre of the undifferentiated rudiment is occupied by a granular fluid; the granules increase in size towards the periphery; in the marginal portion a few, ill-defined nuclei appear, which look as if composed of a large number of granules. A layer of protoplasm surrounds the germinal rudiment, and in this cells are differentiated. Nuclei may be observed to originate within the central mass, and the various stages of sperm-development are grouped in concentric succession round this centre. The rudiment may, in fact, be considered as a giant cell in which the nuclear substance is distributed throughout the cell, and gives rise here and there to young nuclei.

Development of efferent ducts and vesiculæ seminales.—The efferent ducts first appear at the posterior end of the rudimentary testes, as a direct prolongation composed of definitely arranged regular cells. At a later stage the recipient duct is seen as a cylindrical strand, without a lumen, extending nearly the length of a segment, and ending in the fatty body. The development in the caterpillar exhibits a very slow increase in breadth and length, and the gradual appearance of a lumen from before backwards. The vesicula appears as a simple swelling of the vas deferens.

The penis and ductus ejaculatorius first appear in the chrysalis, and are entirely of ectodermic origin. Below the rectum the external epithelium forms a shallow annular depression which gradually becomes deeper. The penis appears as a cylindrical structure raised from the bottom of the depression. The invagination deepens and spreads in a dorso-ventral direction, divides into two portions—one ventral, forming the penis proper, the other dorsal, forming the ejaculatory duct.

Odoriferous Apparatus of Butterflies.*—Dr. E. Haase discusses the various kinds of odours emitted by butterflies. Among those which are shared by both sexes, he distinguishes (1) those which depend on some definite ethereal oil resulting from the food of the caterpillar; (2) protective odours which are emitted as a protection against enemies. The odours restricted to one sex are the various attracting and captivating smells of sexually mature males and females. The latter is illustrated, for instance, by Bombycidæ, where the odour attracts males from a great distance. Without their olfactory antennæ the males cannot discover the females. The males are odoriferous only when the female is capable of flight. The fragrance is very

* SB. Naturf. Gesell. Isis, 1886, pp. 9–10.

variously disposed, on scales on the wings, in thoracic pouches, in pouches on the posterior wings, &c. There are small odoriferous scales, usually occurring. They are generally protected, often associated with tufts of hair, which diffuse fragrance. The various arrangements in several German and tropical forms are briefly noted.

Posterior Sac-like Appendages of some Larval Nemocera.*—Herr A. Jaworowski has studied the development, structure, and function of the above organs on the larvæ of *Corethra plumicornis*, *Culex pipiens*, *Chironomus plumosus*, and *Janyptus variegatus* (?), and notes (1) that they are branchiæ which atrophy at a later stage; (2) that the external membrane is not amorphous, nor hypodermic, but is composed of a compact layer of elongated protoplasmic filaments.

Respiratory System of Odonati.†—Signor D. A. Roster has studied the respiratory system of the aquatic larvæ of various Odonati, and especially of *Æschna cyanea*. He discusses in detail the central and peripheral disposition of the principal tracheæ, and the rectal lamellæ by means of which the oxygen is absorbed from the water. The peculiar papillary terminations on the rectal tracheæ are described and figured. He notes how the oxygen taken in by osmosis in the intestinal branchiæ is distributed and absorbed by the general tracheal system, and how the change of the respiratory organs takes place slowly after five or six days of continuous modification.

Aphis rumicis and a Fungus destructive of the Aphis.‡—The Rev. W. Houghton and Mr. W. Phillips have a notice of *Aphis rumicis*, which in the autumn of last year attacked the mangel-wurzel crops in Shropshire. This aphis becomes infested by a red-coloured fungus closely allied to the *Empusa muscæ*. It may be called *Entomophthora ferruginea* n. sp.

Mallophaga in the shafts of Birds' Feathers.§—M. E. L. Trouessart finds that in some cases *Mallophaga* penetrate into the shaft of birds' feathers, and live there in the same way as do the acarine *Syringophila*. His attention was directed to this mode of life by the perforations which he detected on some of the large wing feathers of a *Numenius arquatus*.

Palæozoic Insects.‖—Over the Palæozoic vestiges of insects not a little controversy has already arisen. Dr. F. Brauer has lately criticized the views of Brogniart and Scudder on the nature of these primitive insects, and has sought to establish the following conclusions:—(1) The Palæozoic insects do not in any way contradict the ordinary opinion as to the derivation of insects from a type like the *Thysanura*. (2) They do not form a special order—the common

* Cosmos Polon., v. p. 204. Cf. Arch. Slav. de Biol., i. (1886) p. 222.
† Bull. Soc. Entom. Ital., xvii. (1885) pp. 260–8 (2 pls.).
‡ Ann. and Mag. Nat. Hist., xviii. (1886) pp. 1–6 (1 pl.).
§ Comptes Rendus, ciii. (1886) pp. 165–7.
‖ Ann. Naturh. Museum Wien, i., Heft 2. Cf. Naturforscher, xix. (1886) pp. 331–2.

basis of those now persisting. (3) The *Hemiptera*, *Orthoptera* proper, *Plecoptera*, *Ephemeridæ*, *Libellulidæ*, and *Neuroptera* proper, are represented in Palæozoic times. The representation is confined, however, to specific groups, to the Cicadas among Hemiptera, *Hemerobidæ* among Neuroptera, *Phasmidæ* and *Blattidæ* among Orthoptera, by dragon-flies among *Libellulidæ*. (4) The Palæozoic forms do not throw any clear light on the origin of other insect orders with complete metamorphosis, nor on the transitional links and synthetic types which connect those already mentioned. (5) Brauer believes that the beetles do not form a transition type from Neuropteran or other Palæozoic insects to the subsequent metabolic forms, but that they represent the end of a typical developmental line, and further, that the division into insects with complete, and insects with incomplete metamorphosis is unnatural. (6) No proof can be advanced in favour of the *Palæo-dictyoptera* of Scudder, or the *Neurorthoptera* of Brogniart. But if the old seven orders of insects be not adhered to, the name *Neurorthoptera* may be well applied to the modern *Plecoptera*, and *Neuroptera* restricted to *Libellulidæ* and *Ephemeridæ*. (7) Erichson's proposal to unite his *Pseudo-neuroptera* in one order, and that with the true *Neuroptera* is quite unnatural and impossible.

Contagious Diseases of Insects.*— Mr. S. A. Forbes gives a detailed account of his observations and experiments on the contagious diseases of certain insects. The ravages of the European cabbage-worm (*Pieris rapæ*) are checked by their liability to a common disease, marked by the whitening of the living larvæ and their rapid post-mortem blackening. The circulating fluids are white and opaque, laden with spherical granules, 5–7 μ in diameter; the mucous membrane of the chylific stomach degenerates; the alimentary fluids and blood exhibit unmistakable micrococci; the fatty bodies undergo immense degeneration.

That the disease is contagious is shown by its unequal distribution in a neighbourhood; by its gradual though rapid progress through a field; by its independence of locality, climate, and weather; by its apparent progress across a country from east to west; by the probable success of infection; and, finally, by its evident bacterial character.

An account is given of numerous cultures and their results, but no opportunity offered for infecting a healthy larva with the microbes.

A more complete study was made of the jaundice disease of the silkworm, which is marked by the yellow colour and restless activity of the larvæ, by the tender skin and free flow of blood, and by the crowding of the blood with the results of tissue degeneration, chiefly of the fatty bodies and blood-corpuscles.

The disease is essentially a premature pupal histolysis of the fatty bodies, or a retardation of pupation which takes unequal effect on the different tissues. This supposed jaundice is also contagious, as was shown from the phenomena of its occurrence; and the

* Bull. Illinois State Laborat. Nat. Hist., ii. (1886) pp. 257–321 (1 pl.).

disease was artificially induced by moistening the food of cabbage-worms with the culture-fluids from the jaundiced silkworm larvæ.

In regard, further, to a breeding-cage disease attacking the yellow-necked apple caterpillar (*Datana ministra*) and the walnut caterpillar (*Datana angusi*), the contagious character and the possibility of infection by the bacterial virus were demonstrated. The cultures (in beef-broth and on thin gelatin films) related to both micrococci and bacilli, which were preserved over winter in plugged or sealed tubes, cultivated the following season, and applied to the food of another species of larva — the zebra caterpillar (*Mamestres picta*)—with satisfactory results.

Finally, in a note on "Muscardine," he attributes largely to this affection the disappearance of a vast host of the forest tent caterpillar (*Clisiocampa sylvatica*) which devastated the forests and orchards of a part of southern Illinois in 1883.

β. Myriopoda.

Brain of Myriopods.*—M. G. Saint-Remy has investigated the intimate structure of the Myriopod brain in *Scolopendra morsitans*. Viewed from above, two transverse pear-shaped lobes are seen. These are applied to one another at their base in the middle line, while terminally they form the optic lobes and give off the optic nerves. They are continued downwards on each side of the middle line into a transversely elongated mass. This mass swells anteriorly to form the two antennary lobes, gives off posteriorly the œsophageal commissures, and forms medianly a thick transverse commissure from which the unpaired median visceral nerve arises.

The brain consists chiefly of medullary substance. Cortical layers of cells cover the upper surface, the optic lobes, &c. Over a small portion of the anterior margin of the upper surface of each of the cerebral lobes, the medullary substance is left uncovered. This region stains very markedly with osmic acid. The exact nature of the formation, which is described in detail, was not determined.

The typical optic lobe, the large antennary, like those of insects, the œsophageal commissures, &c., are briefly described. The whole structure resembles the brain of insects more closely than that of Crustacea or Arachnids.

Sense-organs on antennæ and lower lip of Chilognatha.†—Herr O. v. Rath has studied the histology of the sense-organs on the antennæ and on the lower lip of *Chilognatha*, and has compared them with those of the crayfish and wasp.

I. *Antennary Sense-organs.*—(*a*) *The cones.* Leydig was the first to describe conical processes, usually four in number, which occur on the last joint of the antennæ. Their nervous relations have been lately investigated by Sazepin. Herr von Rath's results are as follows. The antennary nerve divides at the sixth joint into four

* Comptes Rendus, ciii. (1886) pp. 288–90.

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 419–37 (1 pl.).

branches, each ensheathed by long cells with relatively small nuclei and large nucleoli. Each nerve ends in a ganglion of small cells with round nuclei. This lies, for the most part, in the seventh joint. Entering the ganglion the nerve divides into fibres, distributed among the cells; fine fibres pass anteriorly into the cones. The four ganglia are closely approximated. The large cells ensheathing the nerve below the ganglion were identified by Sazepin as ganglion cells. Von Rath gives reasons against this view, and regards them rather as fatty cells. He believes that in the ganglion the fine nerve-fibres come into connection with the "ganglion cells," and that from these, fine processes are given off to the cones. Each fibre would be composed of the processes of a row of these sensory cells, and each cone receives a number of fibres. Each ganglion exhibits peripherally a peculiar dark-coloured strand, with very numerous, deeply stained nuclei, but its nature has not been certainly determined.

(*b*) *The knobs.*—The anterior margin of the seventh, sixth, and usually also of the fifth joint, bear more or less cylindrical rods, without an apical aperture. These knobs have corresponding ganglia, which lie close to the hypodermis and almost imbedded in it. A side branch is given off from the main nerve at the fifth and at the sixth joint, and the ganglia associated with the knobs resemble those of the cones.

II. *Sense-organs of the lower lip.*—The anterior margin of the lower lip usually exhibits two chitinous cup-shaped cylinders. The floor of the cup, generally formed of a somewhat thin membrane, bears a large number of cones, perforated at the apex. They are smaller, longer, and more slender than the antennary cones. A fine hair-like structure sometimes protrudes from the terminal aperture. Similar organs occur on the so-called lobus lingualis of the lower lip. The dorsal surface of this cap-shaped process bears a plate beset with cones, and also another smaller plate directed forwards. These sensory organs of the lower lip have not been previously recognized.

From the lateral and inferior surface of the sub-œsophageal ganglion two nerves arise; each divides into two branches, of which the median leads to the sensory organs of the cap-like process, and the more lateral again divides and supplies the lip-organs first described. The ganglionic arrangements do not differ markedly from those described in connection with the antennary organs. The same sensory and ensheathed cells are to be noted. Herr von Rath regards both sensory cells and supporting cells as resulting from modified hypodermis. He does not discuss the exact function of the organs.

δ. Arachnida.

Nerve-centres of Arachnids.*—M. G. St.-Remy finds that the brain in *Tegenaria domestica*, *Epeira diadema*, and *Phalangium opilio* is formed on the same plan as in *Scorpio*.† There are two sorts of nerve-cells: (*a*) those with a distinct layer of protoplasm around the nucleus; and (*b*) those in which the amount of protoplasm is so small

* Comptes Rendus, ciii. (1886) pp. 525–7. † See this Journal, *ante*, p. 791.

that the nucleus is apparently all that is present, and hence they are called "ganglionic nuclei" by Dietl. These latter occur only in the brain, and more especially in the optic portions of it. They resemble similar cells in insects. The ventral chain consists, as has been shown by Schimkewitsch, of five thoracic and one abdominal ganglia, fused across the mid-line.

The author describes the arrangement of ventral ganglia in *Scorpio*. Here, the last lobe of the ventral ganglionic mass, representing the ganglion for the pectines, has a structure similar to that of the antennary ganglion, and this lends support to the opinion that the former are sense-organs. Nothing like it is found in the Arancina nor in the Phalangida.

Arterial System of Scorpions.*—M. F. Houssay describes the arterial system of scorpions as being formed of two groups of vessels, dorsal and ventral, which are connected with one another by two short vessels at the anterior end, and by an unpaired canal in the middle of the body. The anterior aorta gives off four arteries, and itself terminates abruptly and without ramifying in the cerebroid ganglia. The ventral group is interesting on account of its relations to the nervous system; the blood occupies the space between the two nerve-cords which connect the ganglia; from the cephalothoracic perineural lacuna five trunks are given off on either side.

The connecting arteries of the anterior end envelope the connectives which go from the cerebroid ganglia to the ventral mass. They afford a means of communication between the perineural lacuna and the anterior aorta. The median limb of connection arises from the posterior aorta in the middle of the seventh ring of the "pro-abdomen," and opens into the perineural canal. The author points out the resemblance between this arrangement of the vessels of scorpions and that which obtains in *Limulus* and the Myriopods.

Embryology of Spiders.†—Dr. A. T. Bruce writes that some work done during the past winter on the embryology of several species of spiders, at the biological laboratory of the Johns Hopkins University, brought to light some facts of general interest.

The origin of the lung-book of the spider is particularly interesting, in view of the comparisons instituted between *Limulus* and the Arachnids. From good longitudinal sections of the spider embryo before the disappearance of the abdominal feet, it appears that the lung-book may fairly be regarded as an involuted appendage or appendages. Before the involution of the abdominal appendages, the epithelium covering them assumes the characters of the epithelium of the lung-book. At the same time the appendages become less conspicuous, and slight folds appear on their anterior faces.

By the complete involution of the abdominal appendages, and the increase in the number and distinctness of the folds on their anterior faces, a lung-book would be formed with its laminæ directed backwards. All the stages of the process of involution were not

* Comptes Rendus, ciii. (1886) pp. 354–5.
† Amer. Natural., xx. (1886) p. 825.

observed, but probably in the species of spider upon which the most complete observations were made, two pairs of abdominal feet are involuted.

Whether the conversion of the abdominal feet into the lung-book is to be regarded as an involution of certain paired appendages, as was suggested by Lankester on theoretical grounds, or as a portion of the abdomen over which an appendage corresponding to the operculum of *Limulus* extends, could not be positively determined.

There appears, from one series of sections, to be a swelling corresponding in position to the operculum of *Limulus* just in advance of the involuted abdominal appendages.

Another point of interest in Arachnid embryology is the presence of a fold in the blastoderm, surrounding the cephalic region of the embryo. Balfour described this fold as a groove. It appears, however, when studied by transverse and longitudinal sections, to be a fold of the blastoderm. At the anterior extremity of the fold its opposite sides unite over the median line of the embryo, so that the brain is partially invested by an outer sheath or bag of epiblast formed by the united inner limbs of the opposite sides of the fold.

The origin of this fold and the union of its opposite sides over the middle line of the embryo correspond to the amnion of insects. The difference between the insect amnion and the spider amnion, lies in the fact that in the former the union of the opposite sides of the amniotic fold is in most cases complete throughout the length of the embryo, while in the latter folds are developed only in the head region of the embryo and coalesce at their anterior ends.

Psychical Development of Spiders.*—Herr J. Dahl communicates the results of some observations on the psychical development of spiders. By means of the sensory organs on the palps and limbs, the spiders discover not only the capture of an insect in the web, but the place where it is. *Attus arenatus* was unmistakably influenced by loud knocking. The same species can distinguish a moving object of the size of a fly at a distance of about 20 cm. Distinct vision begins, however, at 2 cm., but then so exactly that the legs of the fly can be distinguished. Beyond the above limit the vision is very indistinct. The above species and *Xysticus lanio* could distinguish colours very imperfectly, but *Epeira cornuta* and *Drassus quadripunctatus* exhibited this aptitude. A male *Epeira patagiata* was able to perceive various odours and to distinguish them. *Thomisidæ* were but slightly sensitive to odours, but *Attidæ* very much so.

Eyes of Spiders.†—Prof. P. Bertkau adds to the numerous recent researches on the eyes of Arthropods, an account of those of spiders. This is based on an investigation of *Micrommata virescens*, *Dolomedes limbatus*, several Thomisidæ, Epeiridæ, &c., but, without entering into the detailed peculiarities of the different genera, it will be enough to summarize his general results.

* Vierteljahresschr. f. Wiss. Phil., ix. Cf. Arch. f. Naturgesch., lii. (1886) p. 83.

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 589–631 (2 pls.).

1. *The lens* is circular in the principal eyes, often elliptical in the secondary. It is biconvex, and the inner hemisphere more than the outer. The cornea is continuous with the general cuticle, and like it exhibits concentric lamellæ of different thickness and refractive index. The outer layer, which is continuous with the pigmented stratum of the cuticle, is generally colourless, but even more pigmented in Attidæ. As in the cuticle, fine canals traverse the lens radially at right angles to the surface, disappearing, however, in the centre. In some lenses a spherical body of undetermined import projects internally, with thicker and more equal layers. The whole lens is penetrated by the perilymph fluid.

2. *Vitreous body and pigment-cells.*—As the corneal lens is continuous with the cuticle, so the pigment-cells and vitreous body represent a modification of the hypodermis, which is in other regions very variable. The pigment-cells round about the lens are long and narrow, with slight cell-walls, finely granular striated protoplasm packed with pigment, and a small fusiform central nucleus. The vitreous body usually consists of polygonal, truncated, pyramidal cells, with very strong cell-walls and yellowish refractive content. The cells are variously disposed more or less symmetrically beneath the lens.

3. *The retina* (*a*) of the principal eyes. The nerve is rarely in the axis of the eye, but usually lateral. It divides within the bulb into several branches, of which one, retaining the old direction, traverses the retina, running often just below the preretinal lamella, and uniting with the retinal cells at the opposite end, while the other branches pursue various courses. The fibres, which, even towards the bulb, have a tubular disposition, probably form a funnel-shaped expansion towards the retinal cell, and while the wall of the former unites with that of the latter, the protoplasmic networks of the two probably also fuse. The nerve-cells are long and flask-like, disposed perpendicularly to the wall of the optic bulb, so that those in front are almost parallel to the preretinal lamella. The large spherical nucleus lies near the base of the cell where the nerve-fibres enter. At the narrowed end, next the preretinal lamella, the "rods" are seen. They are simply the modified peripheral ends of the cells, though sometimes more or less distinct. Other features, such as the chiasma (in Lycosidæ at any rate), are then briefly discussed.

b. The retina of the secondary eyes.—Prof. Bertkau devotes most attention to the *tapetum*, which is not represented in the principal eyes of the true spiders. It forms in the Sparassidæ a connected layer traversing the posterior portion of the optic bulb. Two flaps, united at their ends, inclose a long funnel-shaped space, which may be crossed by narrow bridges. In the Lycosidæ and Thomisidæ numerous parallel clefts have been formed at regular intervals, extending from 1/5–1/3 of the breadth of the tapetum. The system of bands which thus results has a sort of grate-like appearance. The fine structure varies greatly, but no complete account is yet forthcoming. The crystalline particles which give it its beautiful sheen are discussed at some length. Bertkau regards the luminous layer as a kind of secretion.

The "rods" correspond to the different forms of tapetum. In *Micrommata* they are closely packed, perpendicular to the tapetum, without being arranged in rows. Where the tapetum is funnel-shaped the "rods" have a V-shaped arrangement; they are fewer in number, and not surrounded by pigment. In the other type of tapetum, the "rods" are of equal length and disposed in two rows on each tapetum band. Their histological characters are briefly noted. They are still the modified ends of the retinal cells, but are sometimes distinctly composed of two halves. The position of the retinal nuclei, and the characters of the nerve-fibres are then described. This portion of the memoir closes with a brief notice of associated blood-vessels and muscles. After his notice of modifications in the different genera already noticed, Prof. Bertkau sums up in some general statements and comparisons.

Ant-like Spiders.*—Prof. P. Bertkau notes the not unfrequent occurrence of mimicry among Arthropods, and directs attention to the ant-like forms of some spiders. Very frequently the ant-like appearance of insects is entirely superficial, disappearing on close inspection. Numerous Rhynchota, and most familiarly *Alydus calcaratus* illustrate this ant-mimicry. Here the resemblance is chiefly due to the median constriction, the dark-brown colour, the similarity in size, and the slight difference in size between head and tail. In such an instance as the beetle *Clerus formicarius*, the chief resemblance is that of colour.

Among spiders, the *Attidæ* frequently present close resemblance to ants. The cephalothorax and the posterior part of the body are often approximately equal. The *Drassidæ* also exhibit frequent instances of ant-mimicry, as, for instance, in the genera *Phrurolithus*, and especially *Micaria*. Among *Thomisidæ* and *Epeiridæ* ant-mimicry seems impossible, but the *Theridiadæ* furnish a beautiful instance in *Formicina mutinensis*. On elms infested by *Lasius* and *Formica*, an ant-like *Lasæola procox* occurs, but as the mimicry is exhibited only by the developed males, which eat but little, the resemblance must be purely protective.

Heart of Acarina.†—The Acarina have hitherto been described as without hearts. In 1876 Kramer asserted the presence of a pulsating heart in *Gamasus*, and the discovery has been more than confirmed by the researches of Herr W. Winkler.

a. In numerous Gamasidæ Winkler was able to detect the presence of a heart. This reduced organ is a short, broad, compressed chamber, with two valved openings on the upper surface on either side, and a delicate aorta opening freely into the body-cavity above the brain. The lips of each cleft exhibit a muscle-nucleus, and four pairs occur symmetrically on the upper wall of the heart. The heart is moored anteriorly and posteriorly by connecting fibres, attaching it to the dorsal surface. The pulsations are extremely rapid—

* Verh. Naturh. Verein Rheinlands, xliii. (1886) pp. 66–9.

† Arbeit. Zool. Inst. Univ. Wien (Claus), vii. (1886) pp. 111–8 (1 pl. and 1 fig.).

about 200 per minute. Ellipsoidal blood-corpuscles were here and there detected. The circulation is probably effected by energetic peristaltic contractions of the hepatic tubes of the midgut, and of the Malpighian tubes. The heart lies in the anterior portion of the abdomen.

b. A similar heart was observed in *Ixodes ricinus* in nymphs and young females. It lies below the posterior margin of the dorsal shield, above the union of the two median diverticula of the midgut. The pulsations and the position of the clefts were detected, and the passage of blood along the aorta.

c. The heart of Phalangidæ is then described. It possesses two pairs of lateral clefts and has no posterior opening. It lies, as in the above, in the anterior abdominal region. With this the heart of *Cyphophthalmus duricornis* is compared.

d. Herr Winkler also describes the heart of Chernetidæ, which has not been previously observed. In young forms of *Obisium silvaticum* a long heart was seen lying in the first three abdominal segments. There is, however, only one pair of clefts at the very posterior end. The contractile function appears to be restricted to the posterior portion. Towards the aorta, as in Phalangidæ, the heart appears to be separated off by a valvular fold. There is no strongly developed annular muscle as in Phalangidæ.

The single pair of clefts, the marked reduction of the posterior portion of the heart, the narrowing and slight pulsation of the anterior region, seem to mark the heart of the Chernetidæ as a transition type between the elongated hearts with several clefts and the reduced forms in Gamasidæ and Ixodidæ.

ε. Crustacea.

Metamorphosis of Homarus americanus.*—Mr. J. A. Ryder finds that no ecdysis takes place on the hatching of the American lobster: the thin transparent membrane then thrown off being merely an egg-membrane. The first ecdysis takes place from three to six days after hatching, and the first of the seven stages lasts till this time.

During the *first stage*, as in the following three, the larva is essentially a Schizopod, and without abdominal appendages. The larva swims by means of the exopodites of the last six thoracic appendages, the endopodites being merely prehensile. The telson is triangular, with strong spines. During the *second stage*, the second to the fifth abdominal appendages appear. Then between the tenth to fifteenth day the second ecdysis occurs, and the *third stage* is entered upon, when the sixth abdominal appendages make their appearance as biramous lamellæ. The third ecdysis takes place by the fourteenth to eighteenth day, and the *fourth stage* is reached, when the appendages are stronger, but otherwise the larva is similar to the preceding stage. At the end of the third week another ecdysis occurs, leading to the *fifth stage*. The animal now closely resembles the adult, and the schizopodal character of the thoracic appendages has disappeared, the

* Amer. Natural., xx. (1886) pp. 739–42.

exopodites being represented by rounded tubercles. The first pair of abdominal appendages are still wanting. During the fifth week the young larva changes its pelagic character, loses its transparency, and remains at the bottom of the water. The fifth ecdysis precedes the *sixth stage:* the antennæ are now longer than hitherto, and the asymmetrical condition of the chelæ is now apparent. The *seventh stage* ushers in the first pair of abdominal appendages, which are alike in both sexes; the sexual difference being apparent only after the next ecdysis, which takes place seven weeks after hatching, and the larva now reaches the *eighth stage*, when the animal takes on its adult form.

Monstrosities amongst Young Lobsters.*—During his study of the development of the lobster, Mr. J. A. Ryder noted four types of double monsters.

The *first type* had no eyes; the abdomens were separate, the cephalothoraces being fused anteriorly and laterally.

The *second type* had a single eye on the line of fusion of the cephalothoraces.

The *third type* was similarly bifid posteriorly, but there were two eyes, one corresponding to the left of one lobster, the other to the right one of the second.

The *fourth type* had the cephalothoraces fused dorsally; the eyes and appendages were paired in each lobster.

The fusion in these cases, where, as in the case of vertebrate double monsters, the unpaired organs are fused, is due to fusion coincident with gastrulation, and the gradual formation of the organs of the two embryos. This principle extends the application of the theory of concrescence.

Post-embryonic Development of Telphusa.†—Signor Dott. F. Mercanti gives an account of the post-embryonic development of *Telphusa fluviatilis* Lat. The earliest free stage was referable to the Megalopa type. This form is described and further changes noted, but as these consist in detailed modifications of segments and appendages, they do not admit of ready summary. His results go to confirm the opinion that *Pseudotelphusa speciosa* is an ancestral type of the above form.

Development of Oniscus murarius.‡—Herr J. Nusbaum finds that the endoblast is not formed at the expense of the vitelline cells, but arises independently; this is in agreement with what has been found by Kowalevsky in insects and scorpions. The walls of the heart arise from the mesoderm, which is not, as in insects, formed of closed and distinct somites, but the mesodermal cells are scattered. The term of cardioblasts is applied to those cells which form the heart; this organ grows from behind forwards. In a number of points the author confirms the results of Prof. Bobretzki.

* Amer. Natural., xx. (1886) pp. 742-3.
† Bull. Soc. Entomol. Ital., xvii. (1885) pp. 209-16 (1 pl.).
‡ Zool. Anzeig., ix. (1886) pp. 454-8.

Development and Structure of Pedunculated Eyes of Branchipus.*—Prof. C. Claus finds the rudiments of the lateral eyes of *Branchipus* in meta-nauplius larvæ; the pigment and the first crystalline cones appear in the lateral parts of the eyes, the derivates of the hypodermal cells being divided into a superficial layer for the formation of the cones, and a deeper layer for the nervous rods and pigment. The optic ganglion is divisible into a distinct retinal part, and a proximal segment which is united with the cerebrum.

The eye of *Branchipus* is simpler than any other pedunculate eye; special pigment-cells being absent in the vicinity of the nerve-rods and of the crystalline cones; the cornea is not facetted, and, as in the eyes of *Phronima* and of *Apus*, there is a special layer of hypodermal cells above the crystalline bodies; this layer, the absence of facets and of special pigment-cells, together with the presence of interstices for the circulation of the blood in the nerve-bundle layer, and the layer of crystalline cones, are the characteristics of the Arthropod compound eye; the appearance of corneal facets is due to the deficiency of the superficial hypodermal layer, and is a secondary phenomenon.

Vermes.

Genital Organs of Hirudo and Aulastoma.†—M. C. Chworostanky, in opposition to M. Rémy Saint Loup, asserts that the testicles are generally arranged in nine and not ten pairs; the independent glands of the French anatomist are the folds of the wall of the vas deferens; he also makes some additions and other corrections to what is known with regard to the gonads of these two leeches.

Reproductive Organs of Earthworms.‡—As the result of his investigation of the reproductive organs of *Lumbricus* Dr. C. Neuland has established the following conclusions:—

1. The stroma of the ovary is by no means homogeneous.
2. Each ovum contains two solid germinal spots.
3. The receptacula seminis are ontogenetically invaginations of the integument, and with this a multiplication of the unicellular glands is associated.
4. The seminal vesicle is to be regarded *in toto* as testis.
5. There are thus two testes.
6. Part of the reproductive material is used in the cocoon as nutriment for the more vigorous.

Endothelium of Lumbricus and Arenicola.§—M. H. Viallanes finds that the endothelium which invests the muscular bundles of *Arenicola* are distinguished from those of *Lumbricus* by the irregular contour of the cells of which it is composed. The endothelial covering of the ganglionic chain of *Arenicola* is probably incomplete, as the nervous centres remain closely connected with the hypodermis.

* Anzeig. K. Akad. Wiss. Wien, 1886, p. 60. Cf. Ann. and Mag. Nat. Hist., xviii. (1886) pp. 79–80.

† Zool. Anzeig., ix. (1886) pp. 446–8.

‡ Verhandl. Naturh. Ver. Rheinland, xliii. (1886) pp. 35–54 (1 pl.).

§ Ann. Sci. Nat., xx. (1886) Art. No. 3, 10 pp., 1 pl.

In *Lumbricus* the investment is continued on to the nerves which arise from the chain. In *Arenicola* the covering of the nephridia is so arranged as to call to mind the elements which are found on the inner surface of the lymphatic capillaries of vertebrates. The septa resemble the fenestrated epiploon of a mammal, being, in *Arenicola*, formed of connective fibres bounding a number of openings; they are further provided with extremely long smooth muscular fibres, but they are comparatively scanty in number.

Acanthodrilus Layardi.*—Mr. F. E. Beddard describes a large species of earthworm from New Caledonia, which he calls *Acanthodrilus Layardi;* it agrees with the two known New Caledonian species—*A. ungulatus* and *A. obtusus*—in having the generative pores on the seventeenth and nineteenth segments, and appears to be in various characters like one or the other. It is most interesting in regard to the very remarkable glands which are irregularly developed in various specimens in connection with certain modified setæ; these sausage-shaped glandular bodies appear to be absent from immature specimens.

Microchæta rappi.†—Mr. F. E. Beddard gives an account of the anatomy and systematic position of the gigantic earthworm of the Cape Colony, and he institutes a new genus for its reception. The clitellum is only developed in the dorsal region, and extends from the tenth to the thirtieth segment; the vasa deferentia open on the eighteenth, and the ovaries are placed on the anterior wall of the thirteenth segment; the alimentary canal has no cæca or special glands.

The nephridia, which open in front of the upper pair of setæ on either side, are very remarkable; their ducts are provided with long oval sacs, and each consists of a tuft of coiled glandular tubes which communicates with a wide duct which narrows abruptly into a short thick tube; near its external orifice the duct gives off a long cæcal oval tube. From the twenty-eighth segment backwards the form of the nephridium is a little different. There are no true copulatory pouches. The dorsal vessel consists of two tubes, which are only fused here and there; the blood capillaries of the very small ovaries are frequently dilated on their course; the terminal apertures of the vasa deferentia are continuous with the testes.

Studies on Earthworms.‡—Mr. W. B. Benham describes three new genera belonging to the intra-clitelline division of the earthworms. *Urobenus brasiliensis* resembles *Urochæta* in the possession of similar intestinal glands and of pyriform sacs, but it differs by the possession of a distinct prostomium; it is interesting as possessing both the "glandes de Morren" of *Urochæta*, and the intestinal cæca of *Perichæta*, but unfortunately the condition of the specimens examined did not allow of a satisfactory examination into their structure; the typhlosole is a simple fold, and not a cylindrical

* Proc. Zool. Soc. Lond., 1886, pp. 168–75.
† Trans. Zool. Soc. Lond., xii. (1886) pp. 63–76 (2 pls.).
‡ Quart. Journ. Micr. Sci., xxvii. (1886) pp. 77–108 (2 pls.).

valve as it is in *Lumbricus*. The structure of the nephridial tubule and the shape of the funnel calls to mind the common earthworm.

Diachæta Thomasii g. et sp. n. is from St. Thomas, W.I., and has the setæ all simple and not bifid as in *Urochæta*; excepting the most ventral they alternate as in *Pontoscolex* and *Geogenia*. *Trigaster Lankesteri* is another new genus and species from St. Thomas, which is remarkable externally for a deep median ventral fossa in the anterior region of the clitellum; it is bounded by two papillæ, and is doubtless used in copulation. It has three distinct gizzards separated from one another by œsophageal regions. The author concludes with some remarks on the genera established by Kinberg, and on recent additions to the literature of earthworms.

Variations in Perionyx excavatus.*—From an examination of more than 400 specimens of this earthworm, Mr. F. E. Beddard has noted a number of variations in respect of the position and number of the genital pores, corresponding to a similar variation of the internal genital organs, and accompanied by a shifting of the clitellum. Amongst the fifteen variations, for instance, in one specimen the whole series of pores is carried forward one or more segments, as is also the clitellum, which has the normal number of segments composing it. In other cases the pores are further back than in the normal worm; in several cases the female pore, which is normally single and median, is paired, and in other cases the median pore is repeated in two segments. In one specimen there are four male pores, as is usual in *Acanthodrilus*, and both pairs lie in segments anterior to the normal position of the single pair of male pores. The spermathecæ are also sometimes reduplicated, being four on each side, instead of two.

The author considers these to be varietal and not specific differences from the following facts:—(1) The exact correspondence in size and colour, and in all other anatomical characters, except these genital organs. (2) The fifteen variations are represented by only a few specimens, only three being found in more than one specimen. (3) Earthworms are known to vary somewhat in structure, e. g. *Perichæta indica*; and (4) the probability of the occurrence of variations.

It is noteworthy that the variations occur in the very series of organs which are used to divide up the Lumbricidæ.

The author points out that Perrier's division of the group must be modified, and that we must distinguish only two groups, according to whether the clitellum commences in front of the male pore, or behind it.

Variation in other organs was not observed, except in the case of the nephridia; in one specimen one of the nephridiopores was found to be displaced dorsally.

Anatomy of the Naidomorpha.†—Herr A. Stolc has some notes on the entire vascular system of *Nais elinguis* and *N. barbata*. In their

* Proc. Zool. Soc. Lond., 1886, pp. 308–14 (4 figs.).

† Zool. Anzeig., ix. (1886) pp. 502–6.

anterior segments the course of the circular and longitudinal vessels of the midgut is so regular that the quadrate interspaces are always very striking; further back the circular vessels branch somewhat irregularly, and in the hindermost segments there is the most irregular communication of the several capillaries. It seemed to be impossible to regard this vascular system as a mere blood-sinus, as Voigt has lately suggested in the case of *Branchiobdella*.

The dermal sensory organs of *Ophidonais serpentina* and *Slavina appendiculata* are next mentioned; in contradistinction to Mr. E. C. Bousfield, the author finds that they are quite different in these two genera. The generative organs of *Nais elinguis* are ripe in the second half of February, at which time *N. barbata* is still reproducing itself asexually by gemmation and fission; the species, therefore, are distinct, and ought not to have been united by Semper and Timm. With regard to the details of their structure Herr Stolc finds himself in agreement with Vejdovsky.

Histology of the Nervous System of Chætopoda.*—Dr. E. Rohde gives an account of his investigations into the histology of the nervous system of the Aphroditeæ. If *Sthenelais* be selected for the study of the colossal nerve-fibres these are found to traverse the whole nervous system from front to back, to run from behind forwards, and starting in each segment on each side from the nervous system, to run to the periphery. They are the processes of colossal ganglion-cells. The ganglion-cells are without exception unipolar, but in other points of structure they exhibit great variation; some are faintly granulated and rather small, lie in large packets and have a pyriform shape; others are very large, spherical, and darkly granulated, and are always arranged singly. Both kinds are devoid of a cell-membrane and are imbedded in a network of fibres which appears to arise from subcuticular cells. The colossal cells are traversed in all directions by fibrils of different strengths, which issue from all points of the periphery of the cell; it is not certain whether the ganglion-cells are united with one another by the fibrils.

Antennæ of Eunicidæ.†—M. E. Jourdan finds that the antennæ of the Eunicidæ consist of a cuticular envelope, an axial nerve, and intermediate cells. The cuticle is exceedingly delicate, has no glandular pore, but some very fine hyaline cilia. Below it there are cylindrical cells, set in a single layer, which call to mind the arrangement and form of the ependyma of some vertebrates; some of the cells are rodlike, and there are also very fine fibrils arranged in bundles among the epithelial cells; the function of these last is probably sensory. The cells have basal prolongations which interlace and form a kind of fibrillar sheath around the axial nerve. Some of the cells are bipolar, and there is every reason to suppose that they are nervous in function. It would seem that the rods and fibrillar bundles of the epithelial layer are especially sensory, and that the other elements are protective and supporting.

* SB. Preuss. Akad. Wiss., 1886, pp. 781–6. See Ann. and Mag. Nat. Hist., xviii. (1886) pp. 311–6. † Comptes Rendus, ciii. (1886) pp. 216–8.

Branchial Skeleton of Sabella.*—M. H. Viallanes recommends the maceration of the anterior end of a *Sabella* in a one-third per cent. solution of alcohol, for the study of its branchial skeleton. It is composed of a pair of basilar plates, each of which is inclosed in the corresponding branchial lobes; each plate is formed of a very thick envelope of connective tissue and a central mass of cartilage; the latter consists of very large cells with thick walls, closely packed against one another and showing no signs of any fundamental substance. In calling this structure cartilage, the author is careful to note that he follows preceding writers, and that he by no means identifies it with what is called cartilage in vertebrates. In the antenna the hypodermis is formed by a layer of cylindrical cells provided with very long vibratile cilia; the cartilaginous axis is in direct contact with the lower surface of the hypodermis by one of its edges, and by the other with a vessel which extends the whole length of the antenna; this vessel is set in a large lymphatic lacuna, which contains also nerves and muscles. The axis is formed by a central set of cartilaginous cells which are invested by a very thick sheath; this last is very complex in structure. It is best studied after maceration for twenty-four hours in a third per cent. solution of alcohol, staining with picrocarmine, and putting in glycerin; further study is aided by teasing. The author comes to the conclusion that the so-called cartilage resembles in structure the notochord of vertebrates, while its "perichondrium" recalls the fibrous sheath which invests that rod.

Conodonts.†—As the result of their study of Conodonts, Herrn K. v. Zittel and Dr. J. V. Rohon have been led to conclude that these structures are neither related to the dentine teeth of Selachian or other fishes, the horny teeth of Cyclostomata, the odontophores of Mollusca, the beaks of Cephalopoda, nor the spines of Crustacea, but do in form and structure closely resemble the oral armature of Annelids or Gephyrea. If this be true, there must have been in Palæozoic times an immense number of very varied worm forms.

Armed Gephyrea or Echiuroids.‡—Prof. M. Rietsch communicates a detailed memoir on the armed Gephyrea or Echiuroids. His investigations are based on two species of *Bonellia*, on *Thalassema Neptuni* and *Echiurus Pallasii*.

1. The memoir begins with a detailed historical survey, and with an interesting account of the habits and external characters of these forms.

2. *The integument.*—The various Echiurians closely resemble one another in the nature of their integumentary layers. There is a constant occurrence of (1) cutaneous glands, more or less concentrated in the papillæ, and sometimes exhibiting highly differentiated structure (*Th. erythrogrammon* Sluiter). (2) A cutis of variable thickness including pigment and a ganglionic plexus; (3) three muscular

* Ann. Sci. Nat.—Zool., xx. (1886) Art. No. 2, 20 pp., 1 pl.
† SB. K. Bayer. Acad. Wiss. München, 1886, pp. 108–36 (2 pls.).
‡ Rec. Zool. Suisse, iii. (1886) pp. 313–515 (6 pls.).

layers, the middle longitudinal, sometimes with regular thickenings, the internal oblique or transverse, sometimes with distinct bundles.

3. *The bristles* of *Bonellia minor* and of the two other types are described in detail. Prof. Rietsch shows in all three the perfect accordance in the structure and musculature of the anterior bristles. These are absent in *Hamingia*, and the posterior bristles are peculiar to *Echiurus* Rietsch agrees with Spengel in regarding the bristles as ectodermic formations arising each from a single cell.

4. *The digestive tube* is described in its three divisions—buccal, intermediate, and anal. There is a great similarity in the different types. The differences depend on the absence in *Thalassema* of a fine layer of longitudinal fibres in the anterior region of the buccal intestine, in the presence of a diverticulum or cæcum, and in the presence (in *Th. Neptuni*) of a (glandular?) ampulla or dilatation at the end of the anal intestine. The *Echiurus* of Pallas exhibits a special glandular region at the anus. The characteristic peculiarities of the intestine are throughout the same, the change in the disposition of the two muscular layers behind the crop, the intimate relations between the anterior portion of the intermediate intestine and the vascular system by means of a ring or sinus, which perhaps secures the nutrition of the blood and thus of the proboscis, the presence of a vibratile groove and of a collateral intestine, with more or less differentiated musculature. An analogous collateral intestine occurs in the Capitellidæ and in the Echinodermata. It has been compared to a transitory cellular strand observed in some Vertebrate embryos (*Selachia*, *Teleostei*, *Batrachia*). Balfour describes its formation in *Selachia* as due to a median dorsal thickening of the intestinal wall, or to a hollowed groove containing a prolongation of the intestinal lumen.

5. *Anal glands.*—The glands situated at the *anus* are very characteristic of Echiurians. They are simple in *Echiurus* and *Thalassema*, doubly ramified in *Hamingia* and *B. viridis*, and simply ramified in *B. minor*. They are above all excretory. The currents caused by the cilia of the funnels, in the gland itself, and in the terminal portion of the intestine, could only cause a current towards the exterior. Water may however pass from the glands into the perivisceral fluid, especially in *Echiurus* and *Thalassema*. Their respiratory function remains doubtful. They have been compared to the organ of Bojanus, to segmental organs, and to diverticula of the digestive tube. Rietsch does not, however, come to any definite conclusion as to their homology.

6. *Nervous system.*—The nerve-trunk has in adult Echiurians lost all trace of segmentation. The bilateral symmetry is, however, sharply accented, not only by the more or less pronounced dorsal groove, but especially by the disposition of the ganglionic cells in two longitudinal bands. *Th. erythrogrammon* is an exception in having its ganglion-cell disposed in a single ventral band. As in certain annelids, the medulla and the branches of the collar are protected by a neural canal, absent in *Bonellias*. The nerves are symmetrical,

though the points of emergence do not usually correspond; they form complete rings, in at least some Echiurians. The nerve-trunk usually floats in the body-cavity, moored by mesentery and trabeculæ; in some *Thalassemas*, however, it rests on a longitudinal muscular elevation and has then lost its usual muscular sheath. The collar is enormously elongated below the œsophagus; its two branches are furnished throughout with ganglion-cells. The nerves end peripherally in a subepithelial plexus, in relation with numerous epidermal cells, generally localized in the papillæ and not much modified.

7. *The vascular system and body-cavity fluid.* — The vascular system consists (1) of a ventral vessel, disappearing posteriorly, and forking anteriorly to form a ring round the proboscis, and (2) of a dorsal vessel, beginning at the anterior extremity of the intermediate intestine. The latter vessel has at first thick swollen muscular walls; it passes straight to the cephalic tube, opening into the above-mentioned ring. Another variable anastomosis between the two vessels occurs. In *Echiurus* the posterior extremity of the ventral vessel opens into a vascular ring round the intestine, but the two branches of this ring only unite at some distance beyond the intestinal walls. From this ring a vessel proceeds to form a second ring round the interbasal muscle of the bristles, and then joins the ventral vessel. This muscle-ring may, however, remain unclosed, when its two branches open directly into the ventral vessel. One might then say that the ventral vessel forms a ring round the interbasal muscle, and that the neuro-intestinal anastomosis forms the superior branch of this ring. A similar arrangement occurs in *B. minor*, and in some *Thalassemas*, but the anastomosis is moved backwards, and passes not into the ramification of the ventral vessel, but into the vessel itself. At the same time, the intestinal ring round the intestine becomes modified into a sinus. The free portion remains normal, so that one sees two vessels issuing from the peri-intestinal pouch. In *B. viridis*, they only unite just before passing into the ventral vessel, while the two branches of the muscular ring, which forms the ventral trunk, both pass below the interbasal muscle. *Hamingia* resembles *B. viridis*.

The vessels contain the amœboid corpuscles which occur in the perivisceral fluid, and also spherical elements, containing hæmoglobin in *Thalassema* and *Hamingia*, and probably also in the *Bonellias* and in *Echiurus*.

8. *The cephalic lobe or proboscis.*—The highly extensile and contractile proboscis which is so characteristic of Echiurians is next described. The elasticity of all its elements and of the amorphous matrix in which they are imbedded, the abundance of muscles crossing in all directions, the spiral coiling of the nerve-cords and vessels, the very peculiar structure of the latter are all associated with the marked changes of dimension which the proboscis exhibits. The phenomena of extension are not due to an inrush of perivisceral fluid. The lacunæ which are seen in preparations beside the lateral vessels of *Thalassema* and *Echiurus* are evidently identical, they can-

not be different from those of *Bonellia*, and according to Rietsch all are artificially produced. Nor do the ventral lacunæ of *Echiurus* seem different, their occurrence in this form only is explained by the peculiar disposition of the musculature on the inferior surface of the proboscis. In these lacunæ, Reitsch never found ova, sperms, or other elements characteristic of the perivisceral fluid. The lacunæ are not portions of the body-cavity. The musculature is the only active factor in extension and retraction.

The proboscis is remarkable for the abundant nerve-terminations, and for the direct relations between epidermis and nerve-centre. On the anterior surface of the horns in *Bonellia*, there is a special organ of taste and touch. The variable histological structure of the margins is discussed. The lobe discharges sensory, prehensile, and locomotor functions, and attains of course its highest development in *Bonellia*.

9. *Segmental organs.*—The genital pouches of the Echiurians are homologous with the segmental organs of Annelids. Their number varies from one to four pairs in the *Thalassemas*, in the Echiurians there are always two pairs. The funnels end in two long spiral grooves, or in two unequal, extensile lips. In *Thalassema gigas*, which has only one pair of pouches, the funnels are more regular in form, and the same is true of *Hamingia* and *Bonellia*. The first has usually two uteri, but exceptionally only one; this exception is the rule in *Bonellia*. The occurrence of a *B. viridis* with two uteri (Lacaze) also prevents the separation of the single uterus type from the former with paired pouches, or indeed from the segmental organs of Annelids. The reduction to a pair of pouches is probably associated with the sexual dimorphism. If there were several pouches, some ova would run a risk of not being fertilized. The males and the ova are separated within the single uterus till sexual maturity is attained. The eggs when expelled and fertilized are enveloped in a tenacious mucus which remains, connecting the embryos and even the larvæ. There are thus greater possibilities for the sexes falling in with one another.

10. *The ovarian duct, the ovary, and the development of the eggs.*—In some Echiurians (*Thalassema*, *Echiurus*, *Hamingia glacialis*), the primitive ovules are modified directly into ova; in others (some *Thalassemas*, *Hamingia arctica*, and most definitely *Bonellia*) accessory structures in the form of follicle and envelope are formed. In the first case, the germinal elements arise from peritoneal cells forming the external envelope of the ventral vessel. In the second case, they have, according to Spengel, the same origin, but according to Greef they arise from cells within the peritoneal layer. Rietsch's results agree most closely with those of Greef.

A short description is then given of the male *Bonellia*, and the long memoir of 200 pages closes with some notes on the development and on the systematic position of the Gephyrea in relation to the higher Annelids. A classification and diagnoses of the different forms are also added. The monograph is accompanied with very abundant illustrations.

Morphology of the Gordiidæ.*— Prof. F. Vejdovsky is of opinion that although the external form of the body appears to ally the Gordiidæ with the Nematoid worms, the rest of their organization is so different that they ought to be separated from that class of Nematohelminths, and brought into closer relation with the Annulata; the presence of a true cœlom and of mesenteries, as well as the highly developed central nervous system, and the segmental arrangement of their glands, demand this change.

At certain times the so-called cellular tissue may disappear and a cœlom clothed by a pavement epithelium developed; this epithelium corresponds to the peritoneum of Annulates; the enteric canal has, however, no enteric fibrous layer, and herein resembles the enteron of Nematodes. This may be explained by the fact that the Gordiidæ take in no food during their free-living stages, while the conditions of these parts are unknown in the younger and parasitic stages. As in the Annulata, the mesenteries arise by the differentiation of the epithelial layer of the cœlom.

By continuous direct cell-division the so-called cellular tissue gets to fill all the spaces of the cœlom; when this is absorbed their plasma is used for the development of the gonads. The elements of the cellular tissue correspond to the lymph-cells of Annulates, which play an important part in their generative activity.

The relations of the peripharyngeal ganglion are difficult to compare with the nerve-ring of Nematodes, and can be better explained by supposing that there has been a modification of the primitive cerebral ganglion, pharyngeal commissure, and commencement of the ventral cord, owing to the reduction of the pharynx. The histological structure of the suprapharyngeal portion recalls that of the cerebral ganglion of Annulates; the fusion of the commissures with the ganglia leads to the large peripharyngeal ganglion. Both developmentally and histologically the ventral cord agrees with that of Annulata, for it arises from two primitive halves, which are themselves formed by the thickening of the epiblast, and it consists of an inferior layer of ganglionic cells and an upper fibrillar layer, among which are the much-branched processes of the lower ganglionic cells. Although the peripheral system of the Gordiidæ is very different from that of the Annulata, consisting as it does of a lamella connected with the hypodermis, it is not difficult to find homologies between the two; and indeed, *Phreoryctes* has a so-called ventral organ which calls to mind the structure of *Gordius*.

The internal segmentation of the Gordiidæ is exhibited only by the gonads. Other, less important, resemblances between the group which Dr. Vejdovsky seeks to unite are to be found in the structure of the body-wall, the hypodermis of the Enchytræidæ being exactly like that of the Gordiidæ; *Polygordius*, again, has, like *Gordius* (and the Nematoids), no circular muscular layer. The structure of the muscular tissue is of the Annulate and not of the Nematoid type. The author proposes to form for the Gordiidæ a separate order, which may be called that of the Nematomorpha.

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 369–433 (2 pls.).

Intermediate Host of Ascaris lumbricoides.*—Dr. O. v. Linstow finds that *Julus guttulatus* and the closely allied *Polydesmus complanatus* greedily eat eggs of *Ascaris lumbricoides* which have been for a long time in water or damp earth; eighteen hours after eating them the eggshell was found to be dissolved in the intestine; thence the young make their way into the body-cavity. These myriopods have the habit of rolling themselves up, and are no doubt often eaten with the produce of the fields. The whole process of development remains to be worked out.

Vitality of Smut-Anguillulæ.†—M. G. Pennetier has repeated the old observations of Baker, Needham, and Davaine, as to the vitality of *Anguillulæ* in smutty grains of corn. Since 1872 he has kept dried smutty grains in his laboratory, and six or eight of these have been experimented upon every year. The grains are put into watchglasses, exposed under a bell-glass to damp air, and after some days supplied with water. Till last year revivification of the larvæ always occurred, but with decreasing completeness; last year the revivification was hardly demonstrable; this year the results were wholly negative. Fourteen years seems therefore to be about the limit of the resistance to desiccation.

Nervous System of Cestodes.‡—Dr. J. Niemiec has continued his researches on the nervous system of Cestodes, extending his previous investigation of *Tæniæ* to numerous other forms.

1. The nervous system of *Ligula* consists of two longitudinal strands, traversing the entire body, and united at the apex of the head by means of large ganglion-cells, which form the central organ. From the latter ten to twelve nerve-filaments proceed, at first united here and there with the main strands, but extending along the dorsal and ventral surfaces till they gradually disappear in the anterior third of the body.

2. The nervous system of *Schistocephalus dimorphus* resembles the above. Two lateral ganglia are united by a median, and by two—dorsal and ventral—commissures. They give origin to eighteen twigs, of which the two lateral, which are the strongest, extend throughout the entire chain, while the dorsal and ventral filaments are traceable as far as the sixth joint or thereabouts.

3. The nervous centre of the *Bothriocephali* lies near the apex of the scolex. Histologically it resembles *Ligula*. Besides the main strands eight delicate nerves arise, which are here and there united with one another and with the main strands by means of slender commissures. They disappear at the beginning of the neck region. Small branches run forward to the very apex of the head.

4. The complex structure of the nervous system in the *Tæniæ* scolex is a modification induced by the musculature of the suckers and hooks. (*a*) The nerve-ring is an adaptation of the head-nerves to the circular course of the hook-muscles. It is peculiar to *Tæniæ*,

* Zool. Anzeig., ix. (1886) pp. 525–8.
† Comptes Rendus, ciii. (1886) pp. 284–6.
‡ Arbeit. Zool. Inst. Univ. Wien (Claus), vii. (1886) pp. 1–60 (2 pls.).

and is especially distinct only in the species with a circlet of hooks on the rostellum. (*b*) The sucker-nerves result from a proliferation partly of the cerebral mass, partly of the secondary nerves and their commissures. (*c*) Dorso-ventral or transverse commissures and polygonal commissure branches are homologous with the still irregular commissures in the *Bothriocephalus* scolex or *Ligula* head. The regular disposition of the suckers determines the regular distribution of the commissures. The ten branches from the brain are demonstrable through several proglottides.

5. The *Acanthobothriæ* form the transition from the *Tæniæ* to the *Tetrarhynchi*. The ten longitudinal nerves have exactly the same course as those in *Tæniæ*, but the central organ and the head-nerves approach those of the *Tetrarhynchi*.

6. The commissural branches in the *Tetrarhynchus* head are directed more towards the centre than in *Tæniæ*. There are two quite distinct commissures, extending between the lateral ganglia. The nerves of the proboscis are in part modified and strengthened accessory longitudinal nerves.

7. In *Phyllobothrium* and *Anthobothrium* the nervous system is simpler. From a central knot of cells, four strong branches extend upwards, leading into the head lobes and branching there. Lateral strands pass into the chain of joints.

8. The brain varies considerably among Cestodes. In all, well-developed ganglion-cells are most abundant in the middle of the principal commissure. The central position of the ganglionic mass, and the radial disposition of the roots of the longitudinal nerves, results in a symmetry which represents the transition from radial to bilateral. The granular matrix in which nerve-fibres and ganglionic processes usually lose themselves, is not always present. Ganglionic cells seem to occur in all Cestodes.

9. Nerves with nuclei can be certainly demonstrated in the Cestodes.

10. The spongy character of the strands is conditioned by several causes. The nervous elements of the network are variously folded under the strong compression of the longitudinal musculature. Owing to their delicacy, they often seem, on longitudinal section, to be united in protoplasmic strands with occasional cross-bridges. The strands are not unfrequently penetrated by muscle-fibres, and surrounding cells insinuate their processes, which also aid in producing the net-like structure.

11. In the proglottides lateral branches are occasionally given off from the principal strands.

New Parasitic Rhabdocœl.*—M. A. Giard describes under the name of *Fecampia erythrocephala* a new species of Rhabdocœl, which lives for part of its life parasitically on various Decapod Crustacea at Fécamp and Yport. *Carcinus mænas* in its young stages is most ordinarily infested; the parasites live in the body-cavity under the digestive tube, and are partly hidden by the liver. It is 1·5 cm. to 1·8 cm. long, has a cylindrical body, and is attenuated towards its

* Comptes Rendus, ciii. (1886) pp. 499–501.

anterior end. There are no rods in the ectodermal cells, and the muscular wall is very delicate; the anteriorly-placed mouth leads into an indistinct pharynx, which is followed by a rudimentary digestive tube. The supra-œsophageal ganglion gives off on each side two large lateral nerves. The great mass of the body is formed by the genital organs, and their orifice is at the hinder end of the body. Further details as to structure are promised, with illustrations.

When sexually mature the parasite leaves its host, and secretes a cocoon which coagulates in the sea-water; this arrangement may perhaps be compared with that described many years ago by Girard in the American planarian—*Planocera elliptica*.

Dinophilus gigas.*— Mr. W. F. N. Weldon describes a new species of *Dinophilus* from Mount's Bay, near Penzance, which, in addition to other marks of distinction, differs from the species already described by the possession of a well-marked nervous system; the sexually mature forms are nearly 2 mm. long. The central nervous system is closely attached to the ectoderm, and consists of a brain and a pair of lateral ventral nerve-cords. In the substance of the former the two eyes, each of which consists of one or two cells loaded with granules of deep-red pigment surmounted by a small cuticular lens, are imbedded. The lateral nerve-cords diminish in size from before backwards, and in the last segment disappear altogether; no trace of commissures between the cords or of any branches could be found, but the presence of well-developed regions of sense-hairs makes it certain that there is some kind of peripheral nervous plexus. Mr. Weldon does not doubt that when the generative products are mature, the worms rupture their body-wall and die.

Dinophilus appears to be related to the Archiannelids and to have many features characteristic of the ancestor common to those groups (especially Chætopods, Gephyrea, Molluscs, Rotifers, and Crustacea), which have a more or less modified trochosphere larva; the relations of the body-cavity, excretory system, and pharynx point to a Turbellarian origin.

Spontaneous Division in Fresh-water Planarians.† — With regard to the disputed question of the reproduction of fresh-water Planarians by spontaneous transverse division, Dr. O. Zacharias states that he has often observed the process in *Planaria subtentaculata*. At the commencement of the posterior third of the body there appeared a shallow constriction which gradually deepened, while the animal often remained perfectly quiet for several hours. After three or four days it was possible with a magnifying-glass to satisfy oneself of the reality of the division. Separation first took place in the centre, while the sides of the daughter-individual still remained connected with the parent. When the young was completely separated, the head appeared as a small unpigmented process at its anterior end. After twenty-four hours, the eye-spots were apparent, and a new proboscis cavity and a new pharynx were developed. The epithelium of the former is, undoubtedly, of mesodermal origin, a fact which is in

* Quart. Journ. Micr. Sci., xxvii. (1886) pp. 109–21 (1 pl.).
† Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 271–5 (4 figs.).

agreement with what we know of its development. When the supply of food was abundant a new act of fissiparous reproduction is to be observed, before the daughter-bud has attained the proportions of the parent. On the other hand, if the amount of food is reduced or altogether withdrawn, reproduction by division completely ceases. In conclusion, the author reminds us that Dr. v. Kennel observed transverse division in an undetermined species of Planarian, which was found in Trinidad.

Structure and Metamorphosis of Pilidium.*—Prof. W. Salensky commences with an account of the histology of this Nemertine larva; he distinguishes an outer convex surface and umbrella from the inner concave subumbrella; these differ considerably in structure, and are separated by a circlet of cilia. The space between them is filled by a gelatinous mass which contains mesenchym-cells.

The preoral portion of the larva is distinguished by the delicacy of its epidermal layer, the cells of which are flat and quite transparent; their contents are clear cell-substance and finely granular protoplasm, the epidermis of the oral part of the larva (subumbrella) is very much thicker. The author agrees with Bütschli in denying that the frontal pit is the central organ of the nervous system, although it is the homologue of the similarly placed pit in other vermian larvæ; but it is distinguished from the fully developed frontal plate by its simpler structure, so that it may be looked upon as a kind of rudimentary frontal plate. It consists in *Pilidium* of a layer of cylindrical or spindle-shaped cells, each of which is divided, by the character of its protoplasm, into an upper and a lower half. The base of the pit is a fine structureless membrane, whence bundles of fibres take their origin; some of these fibres appear to be muscular, and some to be nervous.

The ciliated circlet is more complicated in structure than is generally supposed; it consists of marginal and ciliated cells, and of a provisional but very well developed nervous system; this last appears to be completely homologous with the nerve-ring discovered by Kleinenberg in Annelids, but is distinguished from it by the greater histological differentiation of its elements. No plexus could be made out in the subumbrella. Correlated with its higher differentiation is the more complicated anatomical structure of the ring; as it passes into the lateral lobes of the trunk portion, there are ganglionic swellings, which form a kind of central apparatus for the larva.

The mesodermal structures are the mesenchym cells and the muscular fibres; the latter may be arranged in three groups,—the pair of large retractors of the frontal pit, the muscular layer of the subumbrella, and the two large muscles of the lateral lobes. The enteric canal consists of an œsophagus and gut, and both are differentiated rather early; the constituent cells of the former are clearer than those of the latter, and less complicated in structure.

The earliest rudiments of the nervous system appear in the form of two ectodermal thickenings, which are developed on either side of

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 481–511 (2 pls.).

the invagination for the proboscis; the anterior thickened parts form the rudiments of the ventral and dorsal lobes of the brain, and the posterior those of the lateral nerve-trunks. The ventral commissure of the central ganglia is formed by the fusion of the processes of the two ventral lobes, and appears much earlier than the dorsal commissure. The lateral nerves are formed as direct continuations of the primitive nervous rudiments, are at first confined to the cephalic region, and only later make their way into the trunk. The author concludes from these results that the cerebral ganglia of Nemertines are homologous with those of Annelids; that the ventral commissure of the former corresponds to that which lies between the two halves of the Annelid brain; that the dorsal commissure is peculiar to Nemertines, and that their lateral nerves correspond to the œsophageal commissure of Annelids. Prof. Salensky discusses the recent studies of Prof. Hubrecht, who asserts the mesodermal origin of the nervous system of Nemertines, and expresses doubts as to the correctness of the observations.

The sheath of the proboscis first appears as a mass of mesodermal cells placed at the tip of the proboscis-invagination; as the proboscis and its sheath grow backwards, the epithelial layer of the former appears as an elongated closed sac with a dorsal direction; the mesodermal portion of the proboscis—the muscular layer and the sheath—have the form of a double-walled cap which surrounds the greater part of the epithelial layer. The mode of development of the proboscis of *Pilidium* is completely similar to that of *Monopora*; here again the author's results are in opposition to those of Prof. Hubrecht, while they confirm his own earlier proposition that the Nemertine proboscis is to be derived from that of the Turbellaria.

Modification of the Trochal Disc of the Rotifera.*—Prof. A. G. Bourne writes:—It is now a generally accepted theory that this structure is the homologue of the ciliated bands of the larvæ of Echinoderms, Chætopods, Molluscs, &c., and of the tentaculiferous apparatus of Polyzoa and Gephyrea, and is often termed in common with these a "velum." This velum presents itself in various stages of complexity. It is found as a single circum-oral ring (*Pilidium*), as a single præ-oral ring (Chætopod larvæ), or as a single præ-oral ring, coexisting with one or more post-oral rings (Chætopod larvæ, Holothurian larvæ). We may here assume that the ancestral condition was a single circum-oral ring associated with a terminal mouth and the absence of an anus, and that the existence of other rings posterior to this is an expression of metameric segmentation, i. e. a repetition of similar parts. With a development of a *prostomiate* condition, a certain change necessarily takes place in the position of this band; a portion of it comes to lie longitudinally, but it may still remain a single band, as in the larvæ of many Echinoderms. How have the other above-mentioned conditions of the velum come about? How has the præ-oral band been developed? Two views have been held in regard to this question.

* Rep. 55th Meeting (1885) Brit. Assoc. Adv. Sci., 1886, pp. 1095-6.

According to the one view, the fact whether the single band is a præ-oral or a post-oral one depends upon the position in which the anus is about to develope. If the anus developes in such a position that mouth and anus lie upon one and the same side of the band, the latter becomes præ-oral; if, however, the anus developes so that mouth and anus lie upon opposite sides of the band, the band becomes post-oral. If we hold this view, we must consider any second band, whether præ- or post-oral to arise as a new development. The other view premises that the anus always forms so as to leave the primitive ring or "architroch" post-oral, i. e. between mouth and anus. Concurrently with the development of a prostomium this architroch somewhat changes its position, and the two lateral portions come to lie longitudinally; these may be supposed to have met in the median dorsal line, and to have coalesced, so as to leave two rings, the one præ-oral (a "cephalotroch"), the other post-oral (a "branchiotroch"). This latter may atrophy, leaving the single præ-oral ring, or it may become further developed and thrown into more or less elaborate folds.

The existing condition of the trochal disc or velum in the Rotifera seems to the author to bear out the latter view as to the way in which the modifications of the velum may have come about; further, these results may be well compared with those recently obtained by Selenka in the Sipunculids. The trochal disc in the Rotifera in its simplest condition forms a single circum-oral ring, as in *Microcodon*. This simple ring may be thrown into folds, so forming a series of processes standing up around the mouth; this is the condition in *Stephanoceros*. There are, however, but few forms presenting this simple condition, and it must be remembered that the evidence for the assumption here made is at present inconclusive. This band may, while remaining single and perfectly continuous, become prolonged around a lobe overhanging the mouth—a prostomium. This condition occurs in *Philodina;* the two sides of the post-oral ring do not meet dorsally, but are carried up, and are continuous with the row of cilia lining the "wheels." There is thus one continuous ciliated band, a portion which runs up in front of the mouth. This condition corresponds to that of the Auricularian larva. The folding of the band has become already somewhat complicated. We have only to go a slight step further and the prostomial portion of the band becomes separated as a distinct ring, a cephalotroch. We find such a stage in *Lacinularia*, where both cephalotroch and branchiotroch remain fairly simple in shape. In *Melicerta* the branchiotroch is becoming thrown into folds. Lastly, we find that in such forms as *Brachionus* the cephalotroch becomes first convoluted and then discontinuous, and further it may become so reduced as to be represented only by a few isolated tufts. In such a form as *Lindia* the branchiotroch has become reduced to be two small patches at the sides of the head.

Defectiveness of the Eye-spot as a means of generic distinction in the Philodinæa.*—Mr. W. Milne discusses Ehrenberg's subdivision of this family, and concludes that the existence of eye-spots

* Proc. Phil. Soc. Glasgow, xvii. (1885–6) pp. 134–45 (2 pls.).

is of no value for generic, though it may be so for specific, distinctions; and he proposes to divide the family thus:—

"I. Those which have a double arrangement of part of the trochal cilia of a distinctly rotulate character.

II. Those which have this double rotulate part suppressed or aborted:—*Callidina* Ehrbg."

The first group the author subdivides thus:—

"1. Those with four toes:—*Philodina*.

2. Those with three toes:—

(*a*) Having the pre-intestinal part decidedly shorter than the post-intestinal or post-anal part:—

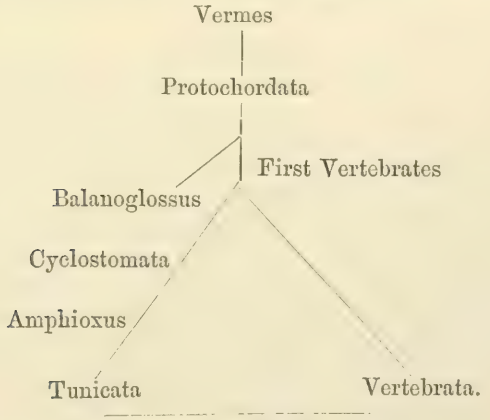
Rotifer, *Actinurus*.

(*b*) Having the pre-intestinal part decidedly longer than the post-anal part:—

Callidina, *Macrotrachela* n.g."

A description is given of these genera, together with that of some of the species. Of *Macrotrachela* none of the species have eye-spots, though *M. constricta* (Dujardin's *Callidina constricta*) has two green vesicles in the position of the eye-spots of other forms. Six other species of this genus are described. In *Callidina* Ehrbg. "the aborted wheels are represented by two wrinkled membranes" within the collar. Two new species are described: one, referred doubtfully to the genus *Diglena* as *D. uncinata*, resembles *Theorus uncinatus* in the presence of two large glands by the stomach, containing each a large vesicle surrounded by granules. In *Stephanops stylatus* there is a strong style on each side of the buccal region, and at the base a green mass, which is the only representative of an eye-spot.

Affinities of Balanoglossus.*—M. R. Köhler, who rejects the idea of any relationship between *Balanoglossus* and the Echinodermata, offers the following scheme of affinity between the Vermes, Protochordata, and various groups of the Chordata.



* Zool. Anzeig., ix. (1886) pp. 506–7.

He regards, that is, *Balanoglossus* as the last representative of a group which had Chordate, but not Vertebrate ancestors; the Lampreys, Lancelets, and Ascidians are, like it, degenerate types.

Littoral Fauna of the Channel Islands.*—M. R. Köhler gives a list of the animals which he collected at Jersey, Guernsey, Herm, and Sark; at Herm the most interesting form was *Balanoglossus sarniensis*, which is described as being long and fairly stout; its body is so soft that a complete example was never obtained. It seems to be about 35 cm. long, and at the collar is about 1 cm. broad. The conical proboscis is of a bright yellow colour, the branchio-genital region is deep orange, and the hepatic green; the terminal portion of the body is colourless. Behind the collar the dorsal surface is rather deeply excavated; there are forty hepatic cæca, which are simple diverticula of the wall of the intestine. Like the other species of the genus it secretes from its cutaneous glands a quantity of mucus, which is described as having in this species the characteristic smell of iodoform.

It may be remarked that the nomenclature adopted by the author is not always that which will recommend itself to the specialists of the various groups which he enumerates.

Echinodermata.

Holothuroidea of the 'Challenger.'†—Dr. H. Theel, who has already reported on the Elasipoda or specially deep-sea forms of Holothurians collected by the 'Challenger,' has issued what is really a monograph of the other orders.

About 150 species were collected, a number of which (especially in the genera *Cucumaria*, *Psolus*, *Stichopus*, and *Holothuria*) are new. The new genera are both aspidochirote, and are *Pælopatides*—a genus with a "brim" round its body—and *Pseudostichopus* in which the ventral ambulacral appendages are not arranged in the three longitudinal series characteristic of *Stichopus;* the anus is hidden in a distinct vertical furrow, and there appear to be no calcareous deposits.

Dr. Theel is of opinion that the common ancestors of all Holothurians were not apodous Synapta-like animals, but cucumariiform, and provided with an open store-canal, ambulacral feet, and a well-developed water-vascular system somewhat like that of Echinids; the Dendrochirotæ appear to have varied in every possible direction, so as to adapt themselves to the various modes of life consequent on the infinitely varying conditions of the littoral zone.

The present shallow water fauna has more outposts in the abyssal zone than has been generally supposed, and representatives are found at the greatest depth, viz. 2900 fathoms, at which Holothurids have been taken, but they are not so common or so characteristic as the Elasipoda. Most of the forms found below 500 fathoms are specifically, though not generically, distinct from the shore-forms. Some species have a vast bathymetrical distribution descending from the

* Ann. Sci. Nat.—Zool., xx. (1886) Art. No. 4, 62 pp. (1 pl.).

† Reports of the voyage of H.M.S. 'Challenger,' xiv. (1886) 290 pp., 16 pls.

shore to 700 fathoms, or deeper. The deep-sea genera appear to be *Pælopatides*, *Pseudostichopus*, *Acanthotrochus*, and perhaps *Ankyroderma*; the Synaptidæ are littoral forms, and the Molpadidæ are making, or have made, their way to great depths.

Six-rayed Holothurians.*—Prof. H. Ludwig found among about 150 specimens of *Cucumaria planci* at Naples five sex-radiate examples; the sixth radius and interradius were observed to be interpolated between the two rays of the bivium, and were more often to the left than the right of the interradius.

Circulatory System of Ophiurids.†—M. R. Köhler finds that the circulatory apparatus of Ophiurids is very comparable to that which he and Prouho have described as obtaining in Echinids. There is the same structure of the madreporic gland, the same relations between it and the exterior on the one hand, and the peribuccal ring on the other; two peribuccal rings give off branches to the ambulacral zones, and there is no aboral circle. In Ophiurids, however, the two rings do not communicate by the Polian vesicles, as they do in regular though not in spatangoid Echinoidea. The Ophiurids want the intestinal vessels which are so well developed in Echinoids.

With regard to the structure of the intestine, there is, as in all Echinoderms, a well-developed internal epithelium, a layer of connective and one of muscular tissue, covered by the general peritoneal envelope. The fourth layer described by Apostolidès—that of external cells—is really the region of nuclei, while his muscular fibres are, in effect, the elongated cell-membranes.

Revision of the Palæocrinoidea.‡—Messrs. C. Wachsmuth and F. Springer define the sub-order Articulata as consisting of their family Ichthyocrinidæ, together with *Crotalocrinus* and *Enallocrinus*; they divide the group into the two families of Ichthyocrinidæ and Crotalocrinidæ, the latter being distinguished by the possession of a ventral tube or anal appendage, placed ventrally near the periphery; the higher radials are also less perfectly developed than in the other family.

The sub-order Inadunata consists of two branches, the first of which is called that of the Larviformia; here we have the Haplocrinidæ, which are the simplest brachiate Crinoids, and represent the larva not only of the Inadunata, but of the Palæocrinoidea generally; the Symbathocrinidæ, which are very closely allied to them; and the Cupressocrinidæ and Gasterocrinidæ, which are dicyclic Crinoids. In some particulars of their arm-structure the Larviformia agree with the Blastoids, and they probably possessed hydrospires; the arms are simple throughout, though exceptionally some of the radials support two arms. The second branch is that of the Fistulata, which is equivalent to the group Cyathocrinidæ, as already defined by the authors; it is now divided into families.

* Zool. Anzeig., ix. (1886) pp. 472–7.
† Comptes Rendus, ciii. (1886) pp. 501–4.
‡ Proc. Acad. Nat. Sci. Philad., 1886, pp. 64–226.

Hypocrinus is distinctly an embryonic type, having a monocyclic base, imperfectly developed radial plates, small sac, embryonic arms, and no pinnules.

A study of *Stephanocrinus* has convinced the authors of the inappropriateness of regarding the Crinoids, Cystids, and Blastoids, as distinct classes; while it is, they think, unquestionably a Palæocrinid, it has the oral and anal pyramid of certain Cystids, and in the general habitus and the position of its ambulacra it agrees with the Blastoids. It must be placed in the Larviformia, among which it forms the type of a new family.

In a note on the underbasal and top stem-joint of Neocrinoidea and Palæocrinoidea Messrs. Wachsmuth and Springer suggest that the inner plate of *Stemmatocrinus*, *Cupressocrinus*, and allied genera, is not a stem-joint, but an anchylosed underbasal disc; when examined from the inner side of the calyx, the plate is seen to form a part of it, and to rest against the lateral, and not the outer faces of the basals.

Cœlenterata.

Classification of the Medusæ.*—Prof. C. Claus resumes some of his previous generalizations on the classification of the Medusæ, and subjects some of Häckel's conclusions to a somewhat polemical criticism. The system of Acraspeda which he elaborates is as follows:—

I. Tetrameralia—with quadrate symmetry.

I. Order: Calycozoa—including the families *Depastridæ*, *Lucernaridæ*.

II. Order: Marsupialia—including the family *Charybdeidæ*.

II. Octomeralia—with octagonal symmetry.

III. Order: Discophora.

1st Sub-order—Catammnata;—including the families *Periphyllidæ* and *Ephyropsidæ*.

2nd Sub-order—Acatammnia.

1. Monostomeæ—including the families *Pelagidæ*, *Cyaneidæ*, *Discomedusidæ*, *Sthenonidæ*, *Aureliadæ*.
2. Rhizostomeæ—including the families *Achirizidæ*, *Cassiopeidæ*, *Cepheidæ*, *Lychnorhizidæ*, *Stomolophidæ*, *Rhizostomidæ*, *Catostylidæ*, *Leptobrachidæ*.

The *Periphyllidæ*, with which he includes *Pericolpa* and the *Ephyropsidæ* (including *Linergidæ*) are grouped as the first sub-order of Discophora, under the Catammnata. The principal characters of this sub-order consist in the persistence of the septal knots ("Septalknoten"), in the presence of 16 pararadial coalesced bands, the "Lappenspangen," and in the resulting configuration of the exumbrella and of the peripheral gastral system. The simple and primitive form of the oral tube is also noteworthy.

* Arbeit. Zool. Inst. Univ. Wien (Claus), vii. (1886) pp. 97–110 (4 figs.).

The second principal group of Acatammnia includes the families *Semæostomeæ* and *Rhizostomeæ*. These are characterized by the absence of septal knots, by the presence of broad coalesced regions between eight radial and eight intermediate canals, and the consequently different character of the peripheral gastro-canal system. An important characteristic also consists in the development of the four oral arms round the mouth.

Ontogeny of Cubomedusæ.*—Dr. W. Haacke's observations on the development of the Cubomedusæ were made on a new species found in the Gulf of St. Vincent, South Australia—*Charybea Rastonii*. Häckel appears to be right in asserting, and Claus wrong in denying that there is an alternation of generation. Dr. Haacke observed in his smallest specimen a stalk-canal traversing the aboral gelatinous disc, by which the gastro-canal system of the young Medusa might be connected with a nurse-polyp (*Scyphostoma*?). The young Medusa has a strongly pyramidal umbrella, and so approaches the Tessera and the Scyphostoma form.

With regard to the sensory knobs it was observed that the species had only two unpaired eyes of unequal size, and both axial in position. They had no vitreous body in the adult, though the young has a structure which may be regarded as such; the young has, moreover, four paired eyes. The velar canals are primitively unbranched.

Formation of a new stalk in Tubularia.†—Dr. H. Klaatsch describes a curious case of abnormal formation of a fresh stalk on the polypes of *Tubularia mesembryanthemum*. The polypes, captured at Trieste along with others perfectly normal, exhibited a blind process springing from the region where the stalk passes into the hydranth. The process was histologically a stalk, and not a special organ or cnidophor. Why this secondary stalk should have resulted, Dr. Klaatsch does not attempt to suggest.

Clavularia viridis.‡—Dr. S. J. Hickson has a preliminary note on this anthozoon, the structure of which shows it to be allied to the extinct *Syringopora*. Both these genera are almost certainly Alcyonaria. The young colonies resemble *Cornularia*, the adult, *Tubipora*. Herein the author finds evidence to support his already expressed view that *Tubipora* should be united with the Cornulariidæ into a group of Stolonifera; *Clavularia* is, in fact, a connecting link.

Anatomy of the Madreporaria.§—In his second contribution to this subject Mr. G. H. Fowler deals with two colonial perforate forms, *Madrepora Durvillei* and *M. aspera*. The former species presents interesting features common to it and the Alcyonaria; there is a marked tendency to an absence of polyps from one (the ventral) side of the branch and branchlets; the axial and abaxial septa are strongly developed, and there is a concomitant bilateral symmetry; there is the

* Zool. Anzeig., ix. (1886) pp. 554–5.
† Arch. f. Mikr. Anat., xxvii. (1886) pp. 632–50 (1 pl.).
‡ Proc. Roy. Soc., xl. (1886) pp. 322–5.
§ Quart. Journ. Micr. Sci., xxvii. (1886) pp. 1–16 (1 pl.).

same differentiation of the (six) mesenteries; and there is distinct dimorphism. Differentiation of functions is, however, incomplete, for both forms are reproductive, and both, apparently, digestive. In *M. aspera* there is an absence of dimorphism; this difference is very remarkable, but in face of the great antiquity of these forms, the similar structure of the colony in both, and the fact that they exhibit a similar differentiation of the mesenteries, it is not to be inferred that their systematic relations are unsound.

In preparing microscopic sections the method of v. Koch was found to be extremely useful.

Ctenophora.*—Prof. C. Claus notes the occurrence in the Adriatic of the beautiful *Deiopea kaloktenota*. He corrects and amplifies Chun's description, though it is possible that the form examined was a different species. After a description of this form, Prof. Claus passes to a discussion of the architecture of the Ctenophore body. He criticizes the conclusions and terminology of Häckel, Chun, and others, and proposes certain improvements. It is not, however, profitable to attempt a summary of a promorphological discussion.

Porifera.

Development of Sponges.†—Prof. A. Götte has some notes on Dr. Heider's late paper on the metamorphosis of *Oscarella lobularis*, in which he allows that some of his generalizations must now be regarded as true of some forms only; he cannot, however, allow the correctness of Heider's supposition that the gastrulæ and their germinal layers are always the homologues of those of other polyplastids.

New Tetractinellid Sponge with radial structure.‡—Dr. W. Lampe gives an account of a new sponge, *Tetilla japonica*, which exhibits a radial symmetry. In form the sponge is ellipsoidal at the oral end, and exactly in the longitudinal axis there is a single circular oral opening; at the aboral pole the sponge gradually diminishes in breadth; the surface is beset by a number of small conical processes, among which are small infundibula, at the base of each of which there is a dermal pore; the edges of the pores are elongated by the palisade-like spicules which project around them.

The author gives a full account of the skeleton, and directs attention to the remarkable radiate and symmetrical structure of the water-canal system; the mouth leads into a cavity which widens out below, and is always continued into six vascular trunks which take an aboral direction; these divide the sponge into an internal core and an external mantle. A multiramified system of tubes traverses the soft parts of the sponge at right angles to the radial canals; when their maze is comprehended it appears that there are antagonistic systems of canals. The dermal pores are constant and are never

* Arbeit. Zool. Inst. Univ. Wien (Claus), vii. (1886) pp. 83–96 (1 pl.).
† Zool. Anzeig., ix. (1886) pp. 292–5.
‡ Arch. f. Naturgesch., lii. (1886) pp. 1–18 (1 pl.).

closed; they are proportionately large, and are connected with fine pore-canaliculi in the subdermal spaces.

The ectoderm is poorly developed; its cells are more or less polyhedral and are never flagellate. The ciliated chambers are ellipsoidal or pyriform and the flagellate cells which line them are closely packed. In each chamber there opens only one fine afferent canaliculus which lies exactly opposite the pole at which the equally delicate efferent duct is found. The whole chamber is very often surrounded by a thin continuous membrane, which lies directly on the basal ends of the flagellate cells; the chambers are widely but unequally divided among the parts of the body. The mesoderm agrees essentially with that of other sponges; the connective-tissue corpuscles are extraordinarily branched, and their processes are always in direct communication with one another.

The sexes are separate; the spermatozoa form in regular masses, and like the ova are mesodermal products. Ova appear to be developed at definite and constant points only. Reproduction may also be effected by budding, and this is seen in both males and females; it is preceded by the collection of masses of amœboid cells between the subdermal cavities.

New Monaxonid Sponge.*—Under the name of *Protoleia sollasi*, Messrs. A. Dendy and S. O. Ridley describe a new monaxonid sponge which closely agrees in many respects with the suberitid *Polymastix*, but is distinguished by a very remarkable spicule, which, both in form and position, reminds one of the characteristic "grapnel" of the Tetractinellida; there are no flesh-spicules.

The importance of this sponge lies in its bearing on the relations of the Monaxonida to the Tetractinellida, and it favours the view that the latter are derived from the former; on this point the authors quote the embryological evidence which has been submitted to them by Prof. Sollas. The conclusion is drawn that a tetractinellid spicule is not of itself a sufficient guide as to the systematic position of any sponge.

Sponges from Port Phillip Heads.†—Mr. H. J. Carter continues his account of a collection of South Australian sponges, the Calcarea being still dealt with; he finds that the facts do not justify the formation of a distinct class for this group of sponges.

Greensand Beds of Sponge remains.‡—Dr. G. J. Hinde gives an account of the beds of sponge-remains which are found in the lower and upper greensands of the south of England. These beds consist largely of the detached spicular remains of siliceous sponges only; in some, the silica of the spicules still retains its original colloidal condition, in which it is negative to polarized light, and readily soluble in caustic potash. The canals of the spicules are very commonly filled with glauconite, which may also replace the

* Ann. and Mag. Nat. Hist., xviii. (1886) pp. 152–9 (1 pl.).
† Ibid., pp. 126–49. ‡ Phil. Trans., 1886, pp. 403–53 (6 pls.).

spicular walls. Entire sponges are absent, but a number of species may be recognized. All four orders of the group are found; the Tetractinellidæ and Lithistids, particularly the *Megamorina* family, being the most abundant.

Protozoa.

Significance of Conjugation in the Infusoria.*—Dr. A. Gruber has been able to convince himself that, with conjugating Infusoria (*Paramæcium aurelia*), the nucleoli of the two individuals copulate with each other. In addition to their union at their anterior parts, the two individuals are united at a point in the hinder third of their body; to this point there moves from the left and right a nucleolus converted into a striated spindle; the two bodies touch one another exactly in the bridge of communication, at first only by their apices, and then more intimately. This conjugation brings about an intermixture of nuclear substance from both sides, and explains what was enigmatical to us in the phenomena of conjugation, and appears to bring the conjugation of the Infusoria into direct relation with the sexual reproduction of the Metazoa; there is an intermixture of different germ-plasmas. If these observations be correct, we must abandon the opinion, apparently supported by facts, that the purpose of conjugation is the rejuvenescence of infusoria exhausted by continual division.

Conjugation of Paramæcium.†—The study of *P. caudatum* has furnished M. E. Maupas with certain new points with regard to the action of the nucleolus in conjugation. The nucleolus, in each of two conjugating *Paramæcia*, divides up into a number of parts, of which all except one is absorbed. This one divides again into two, and of these two nucleolar division products, one remains motionless, whilst the second travels with the apposed *Paramæcium*, and here fuses with the motionless nucleolar product of this individual. The exchange is mutual. The travelling portion is spindle-shaped and longitudinally striated. The new body formed by this fusion then divides up into two, four, and eight. Of these eight parts, three are absorbed, four enlarge and become nuclei, whilst the eighth remains for a time unchanged. Then, when the *Paramæcium* divides, this last part also divides, one half going with two nuclei into each of the new individuals. At the second division, each of these halves again divides, so that each of the four new individuals possesses a nucleus and nucleolus, both resulting from a mixed nucleolar product. In *P. aurelia*, this normal condition is attained earlier than in *P. caudatum*. The diagram accompanying the paper shows these processes and the various stages in the two species.

The period of conjugation at a temperature of 24° C. lasts about 12 or 15 hours; that of "reconstitution for about 35 to 40 hours; in winter the processes extend through about 10 hours more."

* Ber. Naturf. Gesellsch. zu Freiburg, i. (1886). See Ann. and Mag. Nat. Hist., xviii. (1886) pp. 164–5.

† Comptes Rendus, ciii. (1886) pp. 482–4.

The primary nucleus, after taking on a sinuous shape, breaks up and is absorbed during the above processes; but the sinuous condition lasts longer in *P. caudatum* than in the other forms.

The author points out that the Ciliata and the Acinetæ are the only organisms in which the nucleus and the nucleolus are so completely distinct from one another; and this dualism corresponds to a physiological division of labour. Whereas in higher forms the nucleus appears to be the active agent in fertilization, in the Ciliata this function is localized in the nucleolus only, which thus represents an hermaphrodite sexual apparatus. In a state of rest the nucleolus is of small size, but at sexual maturity it undergoes a considerable development, and passes through a series of transformations, recalling fertilization in higher forms. There is an elimination of useless material, and a differentiation into a fertilizing element and an element to be fertilized; the former passing from one conjugating individual to the other; finally, by a fusion of these two elements a mixed nucleus results, like that of a fertilized egg. The phenomena taking place previously to the exchange serve only as a preparation for the sexual act; those that follow re-establish the dual nuclear character, peculiar to the Ciliata.

Zoocytium or Gelatinous Matrix of Ophridium versatile.*—Prof. A. Harker has studied the gelatinous matrix of the organism upon which the infusorium is found. The apparently spheroidal mass is not solid, but forms an irregular hollow spheroid, the hollow usually containing a large bubble of gas. In perfectly fresh slices of the colony, under a power of 300 diameters and upwards, a large number of unbranched threads, regularly divided by septa, are invariably to be found, and on one occasion one of these threads was found in active motion, suggesting a filamentous alga allied to *Oscillatoria*.

The gelatinous mass associated with *Ophrydium* is of a very obstinate character, and resists the action of almost any reagents but strong sulphuric acid. After boiling in distilled water for half an hour the gelatinous character is almost unaltered, and only after prolonged boiling in weak potassium hydroxide could the solution of the jelly be obtained. After some hours' boiling, and subsequent treatment with weak acetic acid to get rid of the carbonate of lime (whole minute crystals are distributed throughout the mass), the residue, a flocculent mass, is found to consist entirely of the threads before mentioned. These do not change colour on the addition of strong nitric acid; nor, again, do they give satisfactorily the celluloid reaction with iodine and sulphuric acid. Their nature remains an open question.

The author adds some further notes on the animal. When light is allowed to fall only on part of the colony, all the animals in a very short time congregate to that part of the zoocytium, and on the whole being freely exposed again to light they partially spread themselves over the surface, though a majority leave the matrix altogether. In tanks they showed no disposition to form new colonies as described

* Rep. 55th Meeting (1885) Brit. Assoc. Adv. Sci., 1886, pp. 1074–5.

by Saville Kent, but collected in masses at the bottom. A sufficient quantity was thus obtained to extract the colouring matter by alcohol in suitable quantities for examination, the result being the separation out of chlorophyll with smaller quantities of xanthophyll, as the author has done in the case of *Euglena*.

Flagellata.*—Dr. A. Seligo communicates the results of his studies of certain flagellate infusorians, which he arranges in the following system:—

I. Amœbomastigoda (Monadina).
  1. Monomastigoda.—*Cercomonas longicauda* Duj.
     Mastigamœba aspera F. E. Sch.
  2. Heteromastigoda.—*Bodo lacertæ* Grassi sp.
     Bodo limbatus n. sp.
  3. Polymastigoda.—*Hexamitius intestinalis* Duj.
     Trichomonas batrachorum P.
     Gyromonas ambulans n. g.

II. Choanomastigoda.—*Salpingœca ampulla* S.K.

III. Phytomastigoda (Volvocina in widest sense).—*Pteromonas alata* Cohn sp.

IV. Ochetomastigoda (Arthrodela).
  Peridinieæ. *Glenodinium Cohnii* n. sp.

V. Stomatomastigoda (Euglenoidina).
  1. Astasieæ.—*Astasiopsis distorta* Duj.
     Rhabdomonas incurva Fres.
     Menoidium pellucidum P.
     Heteronema acus E.
     Petalomonas abscissa Duj.
  2. Anisonemina.
     Entosiphon sulcatum St.
     Plœotia vitrea Duj.

His results show that the Flagellata may be adapted to very varied environment. *Plœotia vitrea* frequents the oxygenated surface, and seems almost fitted for pelagic life. In scarcity of oxygen it rapidly dies. *Glenodinium Cohnii* occurs in very stagnant sea-water, where it is quiescent and reproduces in a palmella-like fashion. In clean water swarm-spores appear. *Ampulla* developes on the surface of stagnant sea-water, on the mouldy pellicle of organic and inorganic elements. *Bodo limbatus* attacks the first products of the decomposition of dead marine organisms, becoming quiescent when these are exhausted. The parasites *Hexamitius intestinalis*, *Trichomonas batrachorum*, and *Bodo lacertæ* are distinguished from one another. The other Flagellata noted are fresh-water marsh forms. With the exception of *Pteromonas* they feed on decomposing plants, &c., or the Bacteria which infest these. *Mastigamœba* and *Petalomonas* devour algæ. The Flagellata seem to be very ubiquitous.

The body is enveloped in a fine *cuticle*, structureless or striated,

* Beitr. zur Biol. d. Pflanzen (Cohn), iv. (1886) pp. 145–80 (1 pl.).

or merely in a thin hyaline cortical layer. The *flagella* are either of uniform strength or somewhat conically narrowed. They are usually sharply defined from the body. A steering tail is often present. The flagella readily degenerate, the protoplasm gathers into a terminal vesicle, and the lash is gradually shortened. In the parasitic and marine Flagellates there are no contractile vacuoles. The nucleus was repeatedly observed, and also division longitudinally and transversely.

New Flagellate.* — Herr J. Krassilstschik describes a new flagellate infusorian which he calls *Cercobodo laciniægerens*, which appear to unite the characters of the Cercomonadina with those of the Bodonina; by its mode of development it shows that it belongs to Bütschli's family of the Rhizomastigina. The creature was found in an infusion of decaying leaves at Odessa. It is small and naked, and has a soft, finely granular protoplasmic body; no nucleolus could be made out. There were generally coarse, bluish-green or brown, highly refractive granules scattered in the body. When swimming freely the form of the body changes a good deal, the hinder half being especially mobile. In addition to the tail-like cercus there are a varying number of appendages, which are not to be called pseudopodia, as they are formed passively and not actively. The tail may be withdrawn into the body, which then becomes of a more regular form. Two cilia directed in different directions can be easily seen, and especially the anterior. The creature may pass into a resting stage, when it appears merely as a flat lump of protoplasm, wherein short and broad pseudopodia are extended; at this period there is no translocation of the body. *Cercobodo* has no eye-spot (stigma).

It is quite one of the smallest of the Flagellata, being 11–13 μ long and 4–5 μ broad, 9–10 μ long and 6 μ broad, or 7 to 8 μ in length and breadth, according to its form at any one moment. It feeds on bacteria of all kinds, and generally feeds when in its free-swimming stage; food can be taken in at any point of the body, but it seems that the bacteria cannot be digested unless they themselves secrete an enzyma; when this does not occur the bacterium is allowed to leave the flagellate. During feeding the pulsating vacuole is often increased two or three times in width.

Neither copulation nor the formation of plasmodia was observed, reproduction being effected only by division, and that during the resting stage; of this process the author gives a short account.

With regard to the systematic position of this new form, it belongs to the group Heteromastigoda, and family Bodonina, of which it is the lowest representative; by its powers of movement, mode of taking food, and great mobility of its hinder end it exhibits affinities to the Cercomonadina; the mode of reproduction by fission only, and the simple encystation without copulation, ally it to the lowest Rhizomastigina. The Monadina, the Euglenoidina, and the Heteromastigoda, formed a connected group, distinct from the Isomastigoda.

* Zool. Anzeig., ix. (1886) pp. 364–9, 394–9.

Endogenous and Exogenous Division in Rhizopods.*—Dr. G. C. Wallich proposes to show that, whereas endogenous division in the naked amœban Rhizopods is the prime factor in normal reproduction, exogenous division is ordinarily a mere mechanical disruption of the body-substance into two or more separate masses, produced accidentally by forces operating from without; it is an abnormal lesion. He thinks it, indeed, doubtful whether exogenous division, as he understands it, ever takes place under strictly normal conditions. He describes a new method of rendering visible the nucleus; ordinary frictional electricity applied to living Amœbæ on a glass slide instantly kills the organism, the body being burst up into a homogeneous-looking mass of granular particles, among which the nucleus formed a very conspicuous object. The discharging knobs communicating with a single small Leyden jar are to be applied on opposite sides of the glass cover in contact with the water between the cover and the slide. Care must be taken not to apply too powerful a discharge.

Notes on Sporozoa.†—Prof. A. Pachinger observed three cases of horses' kidneys being infested and destroyed by a sporozoon—*Eimeria falciformis*. A new form was found in the digestive tract of the domestic cat, and a third, which is perhaps new, and is called *Molybdis entzii*, at the commencement of the small intestine of *Rana esculenta*.

New Species of Hæmatococcus.‡—Dr. F. Blochmann has found in spring or early summer, in fresh-water basins at Schwetzingen, a new species of *Hæmatococcus*—*H. Bütschlii*—in which the investment at the swarming stage has two anterior laterally-directed tubules for the passage of the flagella. There is a semilunar stigma, and two or three contractile vacuoles. The swarming form is about 60 mm. long, and is, with the exception of the most anterior portion and the ends of the pseudopodia, of a uniform green colour; the cause of this colour is not quite certain.

Parasitic on this new species there lives an *Amœba*, which is not unlike *A. limax*. After feeding, its endoplasm is found to be filled by green protoplasmic drops obtained from the *Hæmatococcus*. The *Amœba* fixes itself to the envelope of the *Hæmatococcus*, and gradually penetrates and creeps in; it attaches itself firmly, and protrudes pseudopodia, along which small drops of the protoplasm of the host may be seen flowing into the body of the parasite. When it has had enough it stops, and returns to the attack after a time, eating up its prey bit by bit.

Parasites of the Blood.§—Prof. W. Danilewsky, continuing his researches on the blood, notes the presence of a monad parasite—*Hæmamœbius* (Dujardin). This form was found in the blood of *Emys* and *Rana*, in ill-nourished specimens. It also occurred in the urine,

* Ann. and Mag. Nat. Hist., xviii. (1886) pp. 30–4.
† Zool. Anzeig., ix. (1886) pp. 471–2.
‡ Verh. Naturhist.-med. Verein Heidelberg, iii. (1886) pp. 441-62 (2 pls.).
§ Arch. Slav. de Biol., i. (1886) pp. 85–91.

bile, abdominal transudations, &c. It corresponds exactly to *Hexamitus* Duj., and is referable to the family Polymastiginia, among the Flagellata Isomastigoda. Its variable occurrence and appearance are described. During inanition the structure of the mucosa becomes modified; it becomes more permeable. Young forms may thus pass from the intestinal tract, where they are constant parasites, into the vascular and lymphatic system. It is evident that with deficient nutrition, an emigration of the monads from the empty intestinal canal becomes very necessary.

Prof. Danilewsky has already * described in the blood of birds, (1) a gregarine-like form allied to *Hæmogregarina testudinis* Step. and to *Drepanidium*; (2) *Trypanosoma avium*; (3) a peculiar spherical, flagellate Hæmatozoon. To these he adds some forms which he has recently observed: (*a*) very motile, narrow, flagellate forms, like the Hæmatozoon (*Herpetomonas Lewisii*) in *Mus decumana*; they are found freely in the blood of *Laniadæ*, &c., or in the interior of the red blood-corpuscles; (*b*) a small, spherical, transparent Hæmocytozoon (i. e. within a red blood-corpuscle), which gradually acquires a vermicular form. Internally an apparent nucleus may be demonstrated. Prof. Danilewsky promises a future discussion of the relations and history of these blood-parasites.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.†

Lecithin in Plants.‡—MM. E. Heckel and F. Schlagdenhauffen claim to have discovered a new physiological link between the animal and vegetable kingdoms, in the presence of lecithin in the tissues of a number of plants (but not all) examined by them. The method employed was the production of phosphoric acid by a certain chemical treatment, which acid could result only from the presence of lecithin in the tissues treated.

Thickening of the wall of Epidermal Cells of Cruciferæ.§—According to Herr M. Abraham, this change, which is characteristic of many Cruciferæ, does not begin until the cells have attained the size which they bear in the ripe seed, and is always preceded by the cells becoming filled with starch-grains. The additional layers usually

* Biol. Centralbl., v. (1885). See this Journal, *ante*, p. 635.

† This subdivision contains (1) Cell-structure and Protoplasm (including the Nucleus and Cell-division; (2) Other Cell-contents (including the Cell-sap and Chlorophyll); (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‡ Comptes Rendus, ciii. (1886) pp. 388–90.

§ Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) pp. 599–637 (2 pls.).

begin to be formed on the outer wall, and advance towards the interior of the cell, the starch gradually disappearing. The seeds of *Lepidium sativum* and *ruderale* are distinguished by a homogeneous mucilage which escapes by diffusion; while the mucilage of other seeds which swell up is always differentiated. This mucilage agrees closely in its properties with cellulose; and in the process of growth mucilage is frequently transformed into cellulose, as in the case of *Erysimum cheiranthoides*.

Endoderm.*—M. C. van Wisselingh points out the distinctions between the endoderm and the bundle-sheath of the central cylinder already described by him.† The former is to be found immediately beneath the epidermis or velamen in nearly all roots of Phanerogams (it is wanting in *Helleborus viridis*); the latter appears to be invariably present. Although resembling one another in certain points of anatomical structure, they differ in the endoderm never having the suberous layer which is always so characteristic of the sheath of the central bundle. While the sheath consists of only a single layer of cells, the endoderm is in all cases composed of at least two, and in most cases is extremely well marked by the remarkable differentiation of its cells into longer and shorter, the wall of the long cells resembling that of the cells of bark, while that of the short cells is always very thin, though sometimes considerably lignified.

Conducting-tissue in some anomalous roots of Monocotyledons.‡—Herr M. O. Reinhardt gives the following as the more important results of observations on this subject:—A union of the separate parts of the two conducting tissues (hadrome and leptome) is brought about most completely in the Pandanaceæ by the fundamental parenchyma. In the Cyclanthaceæ the hadrome-bundles unite into plates, anastomosing abundantly, and the same occurs in *Chamærops humilis* and *Areca rubra*. The isolated leptome-bundles do not anastomose so frequently; the outer ones more often coalesce with the peripheral, or the two inner ones into one. The leptome communicates directly with the hadrome through breaks in the mechanical tissue in the Musaceæ, Cyclanthaceæ, and some other species. Hadrome-bundles completely isolated from the stem to the growing-point of the root occur in a few cases. In some palms, two kinds of such bundles are to be distinguished, one lying in the mechanical ring, the other isolated in the fundamental parenchyma. Isolated leptome-groups also occur occasionally. The inner parenchymatous cylinder is completely separated from the hadrome and leptome in the root of many palms by mechanical cells.

Mechanical Tissue-system.§—Herr A. Tschirch proposes to apply the general term Sclerenchyma-cells or Sclereids to all thick-walled cells which are not Stereids or bast-cells; and further to classify the former as follows:—The sclereids in barks and fruits he calls

* Arch. Néerl. Sci. Exact. et Nat., xx. (1886) pp. 427–48 (2 pls.).
† See this Journal, *ante*, p. 271.
‡ Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) pp. 336–66 (1 pl.).
§ Ibid., pp. 303–35 (3 pls.).

Brachysclereids or Bracheids, the star-shaped ophiure-cells Astrosclereids, the bone-shaped sclereids of *Hakea* Osteosclereids. He regards all these varieties as specially adapted for mechanical support of the surrounding tissues.

The osteosclereids, which have often broad and palmately branched ends, are particularly well developed in the leaves of *Hakea*, and are especially adapted to prevent the contraction of the leaves from drying up in hot weather; their form varies considerably in different species. They occur in several species of *Hakea;* also in *Protea*, *Rhopala*, *Stenocarpus*, *Isopogon*, *Restio*, *Kingia*, &c. Of the same nature are possibly the "spicular cells" of *Welwitschia.*

Bracheids occur especially in the testa of seeds; offering a firm resistance to external pressure on the one side and to the drying up of the seed on the other side. But their widest distribution is in the bark; and their function is well seen by comparing the structure of weeping varieties of trees, such as the ash, with the normal; in the former the stereids are much less numerous, and the bracheids which ordinarily accompany them almost entirely wanting. The same is the case also with many climbing plants, such as *Ampelopsis*, *Hedera*, and *Celastrus scandens.*

Another function of bracheids is to promote the flexibility of branches; this is the purpose of the sclerenchymatous layer of the resin-canals of many Coniferæ, and of those which occur so abundantly in the bark of young twigs, where they commonly take the form of tangential bands of bracheids between groups of stereids, forming what the author calls a "mixed ring."

Astrosclereids occur in the leaves of *Camellia*, and in the bark of *Camellia*, *Magnolia*, *Abies pectinata*, *Ostrya*, &c., branching greatly and often dove-tailing among the surrounding parenchyma-cells.

Cambium of the Medullary Rays.*—As the result of observations on the wood of a number of trees, Herr A. Wieler has determined that the cambium of the medullary rays is similar in its character to that of the wood, and persists also during the period of repose in growth; it therefore cannot be a secondary meristem.

Dr. G. Haberlandt,† however, contests this statement in the case of *Cytisus Laburnum* and a number of other trees and shrubs.

Closing of the Scar after the Fall of the Leaf.‡—Dr. L. Staby has investigated the phenomena connected with this process in Dicotyledons, Monocotyledons, Gymnosperms, and Vascular Cryptogams. In the latter class no proper healing-tissue is formed. In the three other classes the process is the same in its general features, and provision is made to prevent the degeneration of the cells proceeding far from the locality of the wound, by the cuticularization of the walls of the adjoining cells, and the stopping of the fibrovascular bundles by gum, or by the isolation of the injured tissue by the

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 73–7 (2 figs.).

† Ibid., pp. 144–50 (1 pl.).

‡ Flora, lxix. (1886) pp. 113–24, 137–43, 155–60 (1 pl.). Cf. this Journal, *ante*, p. 474.

formation of an entirely new layer of tissue, the periderm. The healing of the wound may take place in three different ways, either (1) by desiccation of the wounded surface, as in tree-ferns; or (2) by the formation of cells of a reticulated-fibrous character, as in Orchideæ; or (3) by the formation of periderm.

The formation of periderm is by far the most common process in the healing of wounds. It occurs in all perennial plants, and is one of the most widely diffused examples of secondary growth in the vegetable kingdom. In the case of the fall of leaves the layer of periderm formed in this way is readily recognized by its brown colour.

Assimilating System of the Stem.*—Herr A. Nilsson classifies the variations in the assimilating tissue of the stem under three types, viz.—(1) The assimilating system consists only of assimilating tissue; i. e. this latter serves as well both for conduction and abduction. (2) The system consists of assimilating tissue and abducting tissue. (3) It consists of assimilating tissue, conducting tissue, and abducting tissue. A number of subordinate classes are arranged under each of these types. Light is an important factor in determining the development of the assimilating tissue, the palisade-cells being almost entirely dependent for their formation on a strong illumination.

Comparative Anatomy of the Stem of Dicotyledons.†—M. J. Hérail has compared the structure of the stem in a large number of families of Dicotyledons. The following are the more important general results:—

In the primary cortex of Buxaceæ there are found isolated fibrovascular bundles, which anastomose at the nodes with those of the central cylinder; and the same is the case in the Leguminosæ (Vicieæ), where they are in connection with the leaves. The primary cortex of certain Melastomaceæ incloses fibrovascular bundles which appear to have no connection with the leaves; all the plants of this family have also medullary bundles. The Menispermaceæ have, at first, the typical structure of the stem of Dicotyledons; at a later period fibrovascular bundles appear in the primary cortex of some species, which may be climbing or not. The same is the case in the Schizandreæ, Lardazibaleæ, certain Leguminosæ, and Aristolochiaceæ; but they have no connection with the habit of the species. They are arranged in continuous circles round the central primitive cylinder.

Departing from its ordinary functions, the pericycle is often the seat of an exceptional development of vascular bundles; examples occur in the Calycanthaceæ, Chenopodiaceæ, Phytolaccaceæ, Nyctagineæ, and Aizoaceæ.

The pith very often contains abnormal structures, especially vascular bundles. In the Cucurbitaceæ these are bicollateral, all the tissues having the same origin, exclusively primary; but elsewhere, in the Solanaceæ, Cestrineæ, Nolaneæ, Apocynaceæ, Asclepiadeæ,

* Naturv. Studentsällsk. Upsala, March 30, 1886. See Bot. Centralbl., xxvii. (1886) p. 27.

† Ann. Sci. Nat. (Bot.), ii. (1885) pp. 203–314 (6 pls.).

Myrtaceæ, Œnothereæ, Convolvulaceæ, and certain ligulifloral Compositæ, the internal liber has neither the same structure nor the same origin as that of the normal bundles.

With regard to the connection between the anatomical structure of the stem and the mode of life of the plant, M. Hérail concludes that the unity in the plan of structure of the stem persists through all the modifications or variations to which that organ is subject. The anomalies of structure are independent of the life of the plant; the causes of these anomalies cannot yet be determined.

In respect of variations in the histological structure of the various elements which compose the tissues:—the composition of the wood is independent of the mode of life, but, as a general rule, the diameter of the vessels is larger in twining or climbing plants than in those of ordinary habit. The greater or less development of the ligneous parenchyma and of the medullary rays is in no way dependent on the mode of life of the plant. The tegumentary apparatus is that which is least affected by the conditions of vegetation; its structure is generally uniform throughout a family, not varying according to whether the plant is climbing or erect.

Value of the Structure of the Wood of Dicotyledons for Classification.*—Herr H. Solereder has examined the structure of the wood in 138 orders of Dicotyledons, for the purpose of obtaining an answer to the question whether, in general, characteristic features are constant in the structure of the wood for larger or smaller circles of affinity. He answers the question in the affirmative for families, tribes, genera, and even species. The characters relied on are the distribution of the various lignified elements in the different parts of the stem, and the nature of the thickenings of the walls of the vessels themselves; but only woody plants were examined in the various orders.

Tubercles on the Roots of Papilionaceæ.†—Herr F. Schindler has reinvestigated the structure of the tubercles on the roots of *Trifolium pratense*, *Vicia villosa*, *Anthyllis Vulneraria*, *Ornithopus sativus*, and *Phaseolus vulgaris*, and reasserts his former interpretation ‡ that they are normal organs, localities for the fresh formation of albuminoids to be consumed in other parts of the plant.

Causes of the various kinds of Æstivation.§—Herr K. Schumann classifies the various kinds of torsion which occur in the development of petals under two heads, constant and inconstant. In constant torsions all the different members of a whorl have similar positions, or the corresponding members originate in the same way. They may be either isotropous or anisotropous. To the latter kind belong the quincuncial and decussate imbrications; to the former, when all the members have similar positions, the valvate and the co-

* Solereder, H., 'Ueb. d. systematischen Werth der Holzstructur bei d. Dikotyledonen,' 264 pp., München, 1885. See Bot. Ztg., xliv. (1886) p. 506.

† Henneberg's Journ. f. Landwirthsch., xxxiii. pp. 325-36. See Bot. Centralbl., xxvii. (1886) p. 108.

‡ See this Journal, iv. (1884) p. 588.

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 53-68 (7 figs.).

torted, the latter caused by rhythmical increases and decreases in the energy of growth of aliquot portions of the receptacle. The imbricate æstivation is quite distinct in its origin from the contorted, and varies greatly in its mode of development.

Formation of Buds in Phanerogams.*—Prof. A. Famintzin contests the view hitherto held that so called "axillary shoots" in flowering plants may spring either from the internode above the subtending leaf or from the base of the leaf itself. Among Monocotyledons he has examined the "axillary buds" in seedlings of maize and in stems of *Tradescantia zebrina;* and among Dicotyledons in *Ephedra*, *Casuarina*, *Syringa*, *Populus*, and *Aucuba*. In all these cases he found the "axillary" buds to spring from the internode above the subtending leaf. They are usually more or less oblique, but sometimes horizontal, with the growing point towards the supporting leaf, and the base facing the axis of the stem; and corresponding in all respects to the position of the buds in Mosses and Equisetaceæ. The formation of new tissue takes place much earlier in the subtending leaf than in the internode and bud above it. If these observations represent a general law, there are not in flowering plants any axillary buds in the correct sense of the term.

Anatomy and Physiology of Stinging Hairs.†—Dr. G. Haberlandt has examined the structure of the stinging hairs in a number of plants. The main features show a great uniformity in the multicellular base surmounted by the very large secreting cell. Below the silicified apex of the latter the cell-wall is always very thin. In *Loasa papaverifolia* the brittleness is occasioned by the deposition, not of silica but of calcium carbonate, and in *Jatropha stimulans* by lignification. In other cases the lignified apex is partially or entirely wanting.

The substance which gives the stinging properties to the fluid of the glands of the common stinging nettle is not, as has been generally supposed, formic acid, which could not produce the effect in such small quantities. Dr. Haberlandt also states that the irritation must be produced by a fixed substance, since the dried contents of the gland will cause the ordinary effect of a nettle sting if introduced beneath the skin. He finds always in the fluid a substance which exhibits all the properties of an albuminoid. The substance which produces the inflammation is probably a compound of the nature of an unformed ferment.

Tendrils of Cucurbitaceæ.‡—Dr. O. Müller has examined the structure and the causes of twining in 38 species of Cucurbitaceæ, and divides them into four classes, according to the degree of complexity of the tendrils. Where the tendrils are compound, he regards the basal portion as in all cases morphologically a stem, the branches

* Mél. Biol. Bull. Acad. Imp. Sci. St. Pétersbourg, xii. (1886). See Bot. Centralbl., xxvii. (1886) p. 95.

† SB. K. Akad. Wiss. Wien, xciii. (1886) pp. 123–45 (2 pls.). See Bot. Centralbl., xxvii. (1886) p. 7.

‡ Cohn's Beitr. zur Biol. d. Pflanzen, iv. (1886) pp. 97–144 (3 pls. and 2 figs.).

as metamorphosed leaf-rachis. This is well shown in transitional forms between tendril and leaf in *Cucurbita Pepo*.

In *Cyclanthera pedata* the sensitiveness is far more intense than in any species that has hitherto been described. The circumnutation is completed in from 39 to 75 minutes, the average being 54. Curvature begins to take place after contact with the under side with a solid body for nine or even for five seconds; and 15 minutes suffices for the tendril again to become straight after the irritation has ceased. The temperature and degree of moisture of the air do not appear sensibly to affect the sensitiveness. Spiral coiling begins in 5 and is completed in from 8 to 10 hours, while the portion which embraces the support increases two to three times in diameter, and becomes hard and brittle.

Tendrils which become attached to the support by a mucilaginous excretion occur not only in several species of *Trichosanthes*, but also in *Sicyos angulatus*. In all the species examined the tendril becomes thicker where in contact, but only on the under side. Statements of the contraction of the concave side rest on inaccurate measurements.

Dr. Müller dissents from the ordinary explanation of the curvature of tendrils, that it results from unequal growth of the two surfaces. It depends rather on their anatomical structure. Wherever this is central the tendrils exhibit no power of curvature, but only where the structure is bilateral. All the constituents which readily undergo change are collected on the convex, the firmer ones on the concave side. As long as tendrils are strongly sensitive the sclerenchyma does not become lignified; this finally takes place in the whole of the parenchyma of the clinging portion.

In a further note on this subject* M. P. Duchartre maintains, in opposition to the statements of Darwin, that even when it has not caught hold of any support, a tendril may coil in two, three, or even four successive spirals in opposite directions. He further states that in *Cucurbita Pepo* the formation of the spiral results directly from an important modification of structure which causes the disappearance, in the half of the organ which becomes external, of the fibrovascular bundles; the large-celled medullary parenchyma attaining, at the same time, special development in that portion. This change in the disposition of the vascular bundles Duchartre believes to be a general phenomenon in the Cucurbitaceæ; he finds it also in *Echinocystis lobata* and *Cyclanthera pedata*. The latter species is distinguished by the remarkable projection of the two horns of the crescent, which forms a section of the tendril in its twining portion.

Changes in the Perianth during the Development of the Fruit.† —Herr C. Reiche has examined the mode in which the perianth is thrown off after withering in plants belonging to 45 natural orders. It may take place in three different ways, viz.—(1) By the formation of a small-celled separating zone, usually coinciding with the place of insertion of the perianth; in the Nyctagineæ a portion of the perianth

* Bull. Soc. Bot. France, xxxiii. (1886) pp. 157–69. Cf. this Journal, *ante*, p. 823.

† Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) pp. 638–87 (2 pls.).

remains still attached to the receptacle, and undergoes further development. (2) The perianth simply withers and decays under the influence of the atmosphere. (3) The separation is effected by the growth of the ovary; the base of the perianth usually remains in this case as a membranous fringe. When a perianth whorl persists until the fruit is ripe, as is often the case with the calyx, it may assume some of the functions of the wall of the ovary.

β. Physiology.*

Embryogeny of the Santalaceæ.†—M. L. Guignard describes in detail the structure of the embryo-sac and embryo of *Thesium*. The original nucleus of the embryo-sac divides into two, and each of these again into two, but not always simultaneously. The antipodals do not develope into cells at the bottom of the sac; their nuclei disappear very early. M. Guignard was able to follow the coalescence of the two polar nuclei, giving rise to the secondary nucleus of the embryo-sac. At the summit of the sac the two synergidæ with very small nuclei are readily distinguished from the oosphere, which is inserted laterally, and usually on the inner side nearest the placenta. The oosphere has also a more obvious membrane and a larger nucleus.

In *Osyris* the placenta produces, as in *Thesium*, three ovular papillæ. The embryo-sac originates from a sub-epidermal cell, which divides into two. The lower of these divides into three, and it is the lowermost of these cells which forms the embryo-sac. The embryo-sac in each of the three nucelli is impregnated, but an embryo developes in only one of them. The embryo of *Osyris*, like that of *Thesium*, is without suspensor, resembling that of some Leguminosæ. Neither the ovule nor seed has any proper integument; in the seed it is replaced by the wall of the ovary.

In *Santalum* M. Guignard confirms the more recent statement of Strasburger ‡ that there is, as in other plants, only a single oosphere, which descends, as usual, lower than the synergidæ. One of these, inclosed in a cellulose membrane, persists by the side of the oosphere, and was at one time mistaken by Strasburger for a second oosphere.

The structure of the reproductive apparatus of Santalaceæ is, therefore, of a higher grade than that of Loranthaceæ, and approaches more nearly the ordinary structure of Angiosperms. The antipodals do not disappear so soon in *Osyris* as in *Thesium*. In *Santalum* they remain up to the moment of impregnation. After impregnation the oosphere does not at once undergo division, but accumulates, in the first place, a supply of starch.

Position of the Nectaries in relation to Fertilization.§—Herr K. F. Jordan describes the structure and position of the nectaries in a

* This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

† Ann. Sci. Nat. (Bot.), ii. (1885) pp. 181–202 (3 pls.).

‡ See this Journal, v. (1885) p. 830.

§ Flora, lxix. (1886) pp. 195–210, 211–25, 243–52, 259–74 (2 pls.).

large number of flowers belonging to many different orders of Exogens and Endogens. He finds that it always has reference to the mode of fertilization, and especially to the position of the stamens. As a rule, terminal flowers, or those on long stalks, are regular, or at least, not zygomorphic, and have the nectaries arranged in a regular whorl in the centre. Lateral flowers are generally irregular and zygomorphic, and the nectaries are either exclusively or chiefly on that side of the flower on which the insect seats itself. Special contrivances are described for bringing the anthers near to the nectary at the time that they are discharging their pollen. Sometimes they change their mode of dehiscence in course of development from introrse to extrorse by a torsion of the filament.

Functions of Chlorophyll.*—M. C. Timiriazeff gives a review of the present state of our knowledge on this subject. He first of all points out the source of error in the observations of Draper, Pfeffer, Müller, and especially of Reinke, from the use of too wide a slit, which causes impurity of the spectrum. If a sufficiently narrow slit is used, it is demonstrable that the maximum of decomposition occurs in the red rays, and not in the yellow, as was formerly maintained. By the use of the spectrogram method, it can be shown that chlorophyll is a compound of two immediate principles, the green chlorophylline, and the yellow xanthophyll. M. Timiriazeff further explains the micro-eudiometric method by which so small a quantity as 0·0001 c.cm. of gas can be easily measured. The chief function of chlorophyll, or rather chlorophylline—for the xanthophyll takes no part in it—in the decomposition of carbonic acid, may be stated to be to absorb the rays which possess the greatest energy—being transparent for these energetic rays—and to transmit this energy to the molecules of the carbonic acid which would not of themselves undergo decomposition.

Apical growth of Gymnosperms.†—In opposition to the views of Groom and Schwendener, Herr H. Dingler maintains the general agreement of the mode of growth of Gymnosperms with that of Angiosperms, from a single apical cell. In a number of cases a well-marked tetrahedral apical cell with two or three segments can be readily recognized; in others various arrangements of cells are exposed by a superficial section, the explanation of which is not clear, but he thinks that these cases can also be referred back to a single apical cell.

Resting-periods of Plants.‡—Herr H. Müller-Thurgau discusses this subject at length, and maintains that the winter period of rest of many plants is not dependent on external conditions such as temperature or moisture, but on internal changes, and especially on such as

* Ann. Sci. Nat. (Bot.), ii. (1885) pp. 99–125 (6 figs.). Cf. this Journal, *ante*, p. 281.

† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 18–36 (1 pl.). Cf. this Journal, iv. (1884) p. 408, v. (1885) p. 487, *ante*, p. 470.

‡ Landwirths. Jahrb., 1885, pp. 851–907. See Bot. Centralbl., xxvii. (1886) p. 90.

enable the starch-containing cells to transform their starch into sugar, which is then carried to the part where growth recommences, and the period of rest is thus closed. This is true of such structures as potatoes, and of the leaf-buds of deciduous trees.

Resistance of Plants to Drying.*—Herr G. Schröler has investigated the extent to which plants belonging to various divisions of the vegetable kingdom will retain their vitality under prolonged desiccation. Among flowering plants succulent plants or parts of plants possess this property to the greatest degree. Many seeds also retain their power of germination after being kept perfectly dry for months, or even for many years. Many mosses and some algæ show a remarkable power of retaining their vitality under complete dryness; as also do the spores of fungi and some Schizomycetes, while the hyphæ of fungi perish rapidly when deprived of water.

Respiration of Plants.†—MM. G. Bonnier and L. Mangin describe more at length the experiments on which they found the conclusions already reported of the variation of the amount of respiration at different periods in the life of the plant.

Circulation of the Sap.‡—Prof. E. Godlewski criticizes the almost wholly physical explanations which have been hitherto given of the movement of the sap. Böhm, and especially R. and Th. Hartig, have shown that the sap ascends, not by the peripheral, but by the central portion of the wood. Böhm and Hartig have further demonstrated (1) that the pressure within the fibres and vessels is less than one atmosphere, and (2) that in the same tree, the pressure is always less above than below, and have tried to explain the upward movement by reference to this difference of pressure and to capillarity. In criticizing this theory, Godlewski maintains that it will in no way account for the ascent of the sap to the heights attained in most trees. He finds an explanation in the properties of the protoplasm of the living cells. The cells of the medullary rays and of the wood-parenchyma pass on the sap, step by step, to the mesophyll of the leaves. Many botanists have allowed that the phenomena of root-pressure are not confined to the root; the author maintains that the phenomena are precisely similar in the central cylinder of the stem. In explanation of the entrance and exit of the sap, Sachs had emphasized that the layer of protoplasm round the internal walls of the cells had not the same structure on all sides: where the cell touches other cells, the layer of protoplasm is readily permeable by water passing in by osmosis, but presents great resistance to the passage of water under pressure; but where the cell is in contact with a vessel or fibre, its protoplasmic membrane readily allows water to pass through it under the influence of pressure. Sachs thinks that this difference in the structure and properties of the protoplasmic layer enables the cell to

* Arbeit. Bot. Inst. Tübingen, ii. (1886) 51 pp. See Naturforscher, xix. (1886) p. 398.

† Ann. Sci. Nat. (Bot.), ii. (1885) pp. 315–80. Cf. this Journal, *ante*, p. 651.

‡ Arch. Slav. de Biol., i. (1886) pp. 9–22. Cf. this Journal, *ante*, pp. 283, 477, 653.

take in sap at one side and let it flow out at the other, solely in virtue of its intracellular turgescence. Godlewski criticizes Sachs's conclusion and illustrative experiments, and finds himself forced to conclude that the osmotic turgescence is not enough, and to admit a special, very pronounced action of the living protoplasm.

If a parenchymatous cell has sucked in osmotically a certain quantity of water, the elimination of this water without the substances in solution may occur in two ways, either (1) by increase of pressure from the walls on the cell-sap, or (2) by a diminution of the attraction between the water and the cell-contents. (1) Godlewski supposes that when the turgescence of a cell has attained a certain degree, the layer of protoplasm lining the walls has become more permeable to water at the place where it is in contact with fibre or vessel; and that, at the same time, the whole protoplasm contracts in consequence of (unknown) forces liberated in respiration. (2) Different substances attract water in very different degrees. If cane sugar in the cell be inverted, the cell's attraction for water doubles, and *vice versâ*. But such transformations really occur; and it is in this action of the living protoplasm that the author finds the source of force sufficient to cause the water to mount up the fibres and vessels. He proceeds to apply his theory concretely to the stem of Coniferæ.

The hypotheses on which Godlewski's theory rests are (1) that periodic changes in the disposition of the molecules of the protoplasm may make the latter more permeable to water at a certain time, and at a definite place; (2) that periodic changes occur in the turgescence of the cell, excited by periodic contractions of the protoplasm, or periodic changes in the chemical composition of the cell-contents.

Movement of Water in Wood.*—Herr M. Scheit propounds the theory that, in addition to the ordinary movement of water in wood, there is also a movement of water in the gaseous form, a movement of distillation. The former he regards as being occasioned exclusively by root-pressure. The distillation movement begins as soon as the cavities of the cells and vessels are no longer completely filled with water; and it can only take place when the temperature of the plant decreases upwards, which may result from the low conducting powers of the wood and soil connected with the loss of heat occasioned by transpiration. The vessels are the chief channels of the distillation-movement, while the tracheids serve especially for the condensation of the aqueous vapour.

Transpiration-stream in cut branches †—Prof. F. Darwin and Mr. R. W. Phillips have repeated Dufour's experiments on the effect on transpiration of two opposite incisions in a branch. They find a general difference in the results between Angiosperms and Gymnosperms, the former represented by *Helianthus*, the latter by *Taxus*. In the former case transpiration is reduced to a minimum; in the

* Jenaisch. Zeitschr. f. Naturwiss., xix. (1885) pp. 678–734. See Bot. Centralbl., xxvi. (1886) p. 294. Cf. this Journal, v. (1885) p. 679; *ante*, p. 283.

† Proc. Cambridge Phil. Soc., v. (1886) pp. 330–67 (1 pl.).

latter case it is not affected to any considerable extent by the opposite incisions. These facts are regarded by the authors as opposed to the imbibition theory; and as explicable only on the hypothesis that the movement takes place in the cell-cavity. In the Coniferæ the water can still move from tracheid to tracheid notwithstanding the incisions; while in Angiosperms, all the vessels being cut, the conduction is rendered difficult.

Phytochemical Studies.*—Herren H. Brunner and E. Chuard record the following results of experiments on the chemical constitution of living plants. Glycoxylic acid occurs in very young grapes, together with succinic acid, also in unripe apples, plums, currants, gooseberries, and in rhubarb. The petiole of the rhubarb leaf also contains succinic, malic, and oxalic acids, together with potassium nitrate. The authors have also detected in the sap of plants an acid termed by them gluco-succinic; and either this acid or its nearly related glucoside is stated to be present also in the gooseberry, currant, and banana.

Action of Chlorophyll separated from respiration.†—MM. G. Bonnier and L. Mangin have attempted to estimate the amount of gases exchanged in the living plant by the action of chlorophyll alone compared with that due, during the same period, to respiration. It is difficult to arrive at any definite conclusions; but it may be stated, as a general result, that, while the volume of oxygen disengaged corresponds nearly to that of carbonic acid absorbed, the results are not uniform when the two functions are separated; the amount of oxygen absorbed often exceeds that of carbonic acid disengaged in respiration alone; while the oxygen disengaged often exceeds the carbonic acid absorbed in the action of chlorophyll by itself. These two processes, in fact, seem in a certain sense to compensate one another.

Influence of Ether and Chloroform on Plants.‡—By experiments on *Salix viminalis*, the pea, hemp, and *Saccharomyces cerevisiæ*, Herr F. Elfving finds that small doses of either of these anesthetics in certain cases favour respiration, viz. up to 5 per cent. for chloroform and 15 per cent. for ether; above these proportions they act injuriously. As little as 2 per cent. of chloroform has a perceptible effect in retarding the germination of hemp-seeds. In the case of *Saccharomyces cerevisiæ*, from 1 to 8 per cent. of ether has no sensible effect on respiration. The intensity of alcoholic fermentation is affected by even so small a proportion as 1 per cent. The growth of *Phycomyces nitens* is not affected by ether in the proportion of 1 per cent.; 4 per cent. retards, and 5 per cent. altogether stops it. The sensibility to light of germinating spores of *Chlamydomonas pulvisculus* is increased

* Ber. Deutsch. Chem. Gesell., 1886, pp. 595–622. See Bot. Ztg., xliv. (1886) p. 426.

† Ann. Sci. Nat. (Bot.), iii. (1886) pp. 5–44.

‡ Öfvers. af Finska Vetensk.-Soc. Förhandl., xxviii. (1886). See Bull. Soc. Bot. France, xxxiii. (1886) Rev. Bibl., p. 64.

by ether in certain doses. In anesthetized tissues the chlorophyll-bodies do not take up their nocturnal position, but remain wherever they happen to be at the moment of anesthesis.

Chemistry of the ripening of Seeds.*—M. A. Müntz has examined the structure of starchy and oily seeds at different periods of ripening.

As an example of starchy seeds he took in the first place rye. It was found to contain at all periods of ripening a carbohydrate with no rotatory power, and without action on the copper reagent, but which is transformed as readily as cane-sugar into a levogyrose glucose which reduces Fehling's solution. These properties correspond to those of synanthrose or levuline, hitherto known only in the roots of Compositæ. As the grain ripens, this synanthrose is gradually converted into starch, apparently directly, without going through any intermediate stages.

In grains of wheat as large a quantity of synanthrose was found as in rye; the same substance was found also in grains of barley and oat, but not in maize. The grains of the true cereals contain also, in addition to the synanthrose, a strongly inverting ferment; in the cases of wheat, oat, and barley, the synanthrose has been entirely converted into starch in the ripe seed. The synanthrose was found also in the stem and leaves.

For oily seeds, colza was taken as an example, the carbohydrates were found to be starch, a gum soluble in water and precipitated by alcohol, cane-sugar, and inverting sugar. The oil is formed very rapidly during ripening, at the expense of the starch and glucose; but in the very last period it again suffers some diminution, apparently the result of respiration, since the total weight of the seed is also somewhat reduced.

What is Diastase?†—Herr J. Fankhauser has investigated the chemical processes which go on in germinating potatoes and barley, and finds that the conversion of starch into sugar is not effected by microbes, but by a substance of a perfectly definite composition, identical with formic acid. In a control experiment he demonstrated that formic acid possesses the property of converting starch into sugar.

Action of Diastase and Invertin.‡—Herr H. Müller-Thurgau alludes to several points in the influence of these substances on the vital processes of plants. Their action in relation to temperature differs from most physiological processes in being not inconsiderable even at 0° C. The relative activity of diastase at the temperatures 0°, 10°, 20°, 30°, and 40° is represented by the numbers 7, 20, 38, 60, 98; that of invertin by 9, 19, 36, 63, 93. Diastase acts on starch in the living cells also under a high pressure, amounting to several atmospheres, when the cell-sap is probably saturated with CO_2. Even at ordinary temperatures, CO_2 has the property of increasing nearly

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 45–74.

† Der Bund, xxxvii. (1886). See Bot. Centralbl., xxvi. (1886) p. 323.

‡ Landwirthsch. Jahrb., 1885, pp. 795–822. See Bot. Centralbl., xxvii. (1886) p. 143.

threefold the activity of diastase. The presence of cane-sugar in the sap has but little effect on the action of invertin, while, if any considerable amount of invert-sugar is already present, it is considerably retarded.

Vines's Vegetable Physiology.*—We have here for the first time an original handbook of Vegetable Physiology in the English language, brought down fairly to the present state of our knowledge. Dr. Vines has enlarged the notes of his own lectures at Cambridge, and treats the various divisions of the subject in the following sequence:—Structure and Properties of the Plant-cell (2 lectures), Absorption (2), Movement of Water in Plants (1), Transpiration (1), Food of Plants (1), Metabolism (5), Growth (1), Irritability (6), Reproduction (2). While the results obtained by other observers up to the time of writing are not neglected, the author gives his own views on all the debatable points which arise in the course of his lectures, frequently supported by independent observations of his own. It is the most important original botanical work which has appeared for some years from the English press.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Dehiscence of the Sporangium of Ferns.†—Herr K. Prantl repeats his former statement that the cells of the annulus of the sporangium contain bubbles of air inclosed in a continuous layer of protoplasm which lines the cell-walls, especially the inner ones. This air is absorbed by water which enters the protoplasm through the cell-wall by virtue of osmose, and is again suddenly expelled when the water is withdrawn, causing the rupture of the cell.

Rods in the Intercellular Passages of the Marattiaceæ.‡—Herr H. Schenck has examined these bodies, already described by Luerssen, in several species of *Marattia* and *Angiopteris*. He does not regard them, as Luerssen does, as cuticular thickenings, but finds them to consist of a substance of doubtful chemical composition which is deposited between the cellulose-membrane and the thin cuticularized membrane which clothes the intercellular spaces. They sometimes attain a filiform condition, and are probably organs for the purpose of secretion.

Rhizocarpeæ.§—The portion of Mr. J. G. Baker's Synopsis of the Rhizocarpeæ already published comprises monographs of the genera *Salvinia*, *Azolla*, and *Marsilea*. Of *Salvinia* he describes thirteen species, of which three are new. They are arranged in four groups, distinguished by the structure of the frond. Of the five

* Vines, S. H., 'Lectures on the Physiology of Plants,' 709 pp. and 76 figs. 8vo, Cambridge, 1886.

† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 42–51. See this Journal, v. (1885) p. 276.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 86–92 (1 pl.).

§ Journ. of Bot., xxiv. (1886) pp. 97–101, 274–83.

species of *Azolla*, three are included in the subgenus Euazolla:—macrospores crowned with three float-corpuscles; massulæ of the microspores armed all round with rigid glochidiate processes; root-fibres solitary; and two in the subgenus Rhizosperma:—Macrospores crowned with numerous float-corpuscles; massulæ of the microspores armed on one side with a few weak prickles without glochidiate tips; root-fibres fascicled. The genus *Marsilea* includes forty species distributed into a number of groups, distinguished by the form and structure of the pedicel. Of these forty species two are new.

Fructification of Sigillaria.* — Dr. C. E. Weiss contests the conclusion of Renault † that the Sigillariæ may be divided into two groups, one belonging to Gymnosperms, the other to Vascular Cryptogams. He considers them to be exclusively of the latter character, the cones relied on by Renault as showing an affinity to Gymnosperms not really belonging to *Sigillaria* at all.

Muscineæ.

Development and Dehiscence of the Sporogonium of Hepaticæ.‡—M. Leclerc du Sablon has examined this subject in great detail, taking as a type in the first place *Frullania dilatata*. In the very young sporogonium sixty-four cells are differentiated at the summit; the centre ones are a little more elongated vertically than the rest, and form a kind of cap beneath the epidermal layer. These cells have denser protoplasm and a larger nucleus than the other cells of the sporogonium; and it is from them only that the spores and elaters are developed. Each of them subsequently divides into four by two vertical walls parallel to those already formed; the cap is therefore now composed of 256 cells. These cells now elongate in the direction of the axis of the sporogonium, and then become differentiated into two kinds:—in the one the nucleus undergoes repeated divisions, and these give rise to the mother-cells of the spores; in the other the nucleus does not divide, and the protoplasm forms spiral granulations which become the elaters. These two kinds of cell are equal in number, each alternating regularly with the other.

Variations from this type are described in the cases of *Scapania compacta*, *Pellia epiphylla*, *Aneura pinguis*, *Targionia hypophylla*, *Reboulia hemisphærica*, and *Sphærocarpus terrestris*.

With regard to the structure of the sporogonium, Hepaticæ may be divided into two groups:—1, the Jungermannieæ, where the walls are composed of two layers of cells furnished with ornaments, and opening by four valves; and 2, the Marchantieæ, Targioneæ, and Ricciæ, in which the wall consists of a single layer of cells without ornaments or nearly so, and bursting irregularly at maturity.

* SB. Gesell. Naturf. Freunde Berlin, 1886, pp. 5–12 (3 figs.). See Bot. Centralbl., xxvii. (1886) p. 58.

† See this Journal, *ante*, p. 288.

‡ Ann. Sci. Nat. (Bot.), ii. (1885) pp. 126–80 (5 pls.). Cf. this Journal, v. (1885) pp. 91, 276, 832, 840, *ante*, p. 479.

In the sporogonium of the Jungermannieæ, M. Leclerc du Sablon finds a mechanism of dehiscence similar to that which he has described in the case of anthers, except that the epidermis sometimes takes part in causing the dehiscence along with the subjacent layers. The elaters, by adhering to the walls of the sporogonium, form a kind of brush which sweeps out the spores as the valves curve. The structure and dehiscence of the sporogonium are described in the cases of *Jungermannia bicuspidata* and *alicularia*, *Calypogeia Trichomanis*, *Aneura pinguis*, *Pellia epiphylla*, *Frullania dilatata*, *Fossombronia cæspitiformis*, and *Targionia hypophylla*.

In the Ricciæ the structure and mode of formation of the spores indicate the least differentiation of any class of Hepaticæ. The mass of the sporogonium continues for a long time to be formed of homogeneous parenchyma, and it is only at a comparatively late period that the mother-cells of the spores are set at liberty. In *Riccia* the elaters are entirely wanting; in the other Ricciæ, e. g. *Sphærocarpus*, they are represented by sterile cells without ornamentation, each corresponding to a single spore. The walls of the sporogonium, composed of a single layer of cells without ornaments, do not dehisce in the proper sense of the term, but are irregularly torn at maturity.

In the Targonieæ and Marchanticæ the elaters are well developed, and are furnished with several spirals. The sporiferous tissue also remains long in a parenchymatous condition; but as soon as the central walls are resorbed, the mother-cells of the spores are clearly differentiated from those of the elaters. In the Targonieæ and the greater number of the Marchanticæ the elaters are intermingled with the spores, and do not play any appreciable part in the dehiscence of the sporogonium. The walls of the sporogonium-cells are ornamented, but there is no regular dehiscence.

In the Jungermannieæ the differentiation of the spores and elaters takes place at a much earlier period. In respect to the elaters, the thalloid genera, like *Pellia* and *Aneura*, show a lower type than the foliose genera like *Jungermannia* and *Frullania*. In the latter an elater corresponds to a row of spore-mother-cells. It is also in the Jungermannieæ that we have the most complicated structure in the walls of the sporogonium. They are composed of two layers of cells furnished with ornaments in such a way that, except in *Fossombronia*, the sporogonium dehisces regularly by four valves; and in this group also the foot of the sporogonium is most strongly developed.

Taken as a whole, the characters observed in the asexual generation tend to confirm the classification of the Hepaticæ derived from the vegetative characters and those of the sexual generation.

New Species of Metzgeria.*—Mr. W. Mitten describes three new species of this genus of Hepaticæ, *Metzgeria saccata* from New Zealand, *M. scobina* from Borneo, and *M. nitida* from Australia, the first differing from all species hitherto known in the presence of saccate lobules to the frond.

* Journ. Linn. Soc. Lond. (Bot.), xxii. (1886) pp. 241–3 (3 figs.).

Algæ.

Fertilization of Fucus.*—Herr J. Behrens has closely followed out the structure and development of the sexual organs, and the mode of fertilization, in *Fucus vesiculosus*.

In the male conceptacles the mother-cell of the antheridium is distinguished from the vegetative cells of the paraphyses by its more abundant protoplasm, almost entirely destitute of vacuoles. It contains small disc-shaped chromatophores which continue to divide until the antheridium is ripe. The nucleus divides continually with the ordinary karyokinetic figure, until sixty-four nuclei, the future antherozoids, are formed. Each mature spermatozoid contains a nucleus composed chiefly of chromatin; the yellow spot is a chromatophore which has lost its colour. The cilia are derived from the envelope of protoplasm which incloses the nucleus. The antherozoid is therefore a perfect naked cell. The wall of the antheridium is ultimately composed of two layers, the outer of which becomes resolved into mucilage at its apex, through which the inner layer bursts and is driven out of the conceptacle, ultimately becoming itself converted into mucilage to allow the escape of the antherozoids.

The mother-cell of the oogonium contains a nucleus with a single remarkably large nucleolus and a comparatively small quantity of chromatin, with a large number of small chromatophores. The division of the protoplasm into eight takes place in the same way as that of the antheridia; the resulting oospheres are not separated by any membrane of cellulose; their mode of escape from the oogonium is also the same as that of the antherozoids; an amœboid motion was occasionally seen in them; each invariably contains a nucleus and a nucleolus, as well as a bounding membrane. The application of Zacharias's method, acetic potassium ferrocyanide and iron chloride, showed that the chromatophores, and especially the nucleolus, are rich in albumen, while none could be detected in the rest of the protoplasm.

In the actual process of impregnation, the author was unable to detect the formation of particles to determine the direction of the process such as Dodel-Port has observed in *Cystosira*. The access of the antherozoid could not be followed in living material, but only by bringing a number of oospheres and antherozoids into contact under the cover-glass. The author has no doubt, from the phenomena observed under these circumstances, that the act of fertilization consists in the entrance of the antherozoid into the substance of the oosphere. In those oospheres, and those only, which had been in contact with antherozoids, a second nucleus was observed, which could be derived only from the impregnating antherozoid. The two nuclei ultimately coalesce, and the impregnated oosphere then excretes a cellulose-membrane, and begins to divide.

Formation of Structureless Chalk by Sea-weeds.†—Mr. J. Walther points out that the idea that chalk can only be formed in

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 92–103.
† Science, vii. (1886) p. 575.

a deep sea is an erroneous one. The seaweeds belonging to the Lithothamnieæ, which abound in the Gulf of Naples, contain only from 5 to 6 per cent. of organic matter, nearly the entire substance consisting of mineral matter, chiefly carbonate of lime. On death these plants do not change their form, but become gradually transformed into a structureless substance altogether resembling chalk.

Physiological Anatomy of Algæ.*—Herr N. Wille publishes in greater detail the result of his observations on the various adaptations found in the structure of seaweeds to their mode of life.

Abnormal Forms of Vaucheria.†—Mr. D. H. Campbell describes some singular abnormal developments of *Vaucheria geminata* Vauch. var. *racemosa*. After being kept for a week or two in rather confined quarters, a large proportion of the fertile branches developed abnormally.

In one the antheridium was replaced by a filament in all respects like an ordinary vegetative filament; while in another the antheridium was perfect, but the oogonia were replaced by slender filaments. In another example one oogonium had developed, but its apex was prolonged into a filament; and, again, in another the antheridium was complete, but one of the lateral buds had developed a secondary branch bearing a complete set of sexual organs, a perfect antheridium, and four perfect oogonia. A further abnormality consisted in an addition to the ordinary antheridium of two others with accompanying oogonia from the lateral buds. Finally, in another example, one of the lateral buds had grown out into a filament which bore laterally a smaller branch upon which a perfect antheridium and oogonium and a rudiment of a second oogonium were formed.

Japanese Desmids.‡—Messrs. J. Roy and J. P. Bisset describe a number of desmids from a lake called "Junsai numa," in the island of Yesso, Japan. By far the larger number of species are European, but several new species are described, comprising four of *Cosmarium*, seven of *Staurastrum*, one of *Xanthidium*, one of *Docidium*, and one of *Sphærozosma*.

Structure of the Diatom Valve.§—Mr. J. Deby says that he has in his collection a series of well-mounted slides, which have proved, to his satisfaction, the following facts, most of which are corroborative of previous observations by others:—

(*a*.) That the shell of most diatoms consists of a double plate.

(*b*.) That between these two plates there exist a greater or less number of cavities surrounded by solid walls of silica. These cavities are circular or hexagonal in outline.

(*c*.) That in all recent *living* and perfect valves the cavities are closed at the top by the upper plate, and at the bottom by the lower

* Svensk. Vetens.-Akad. Handl., xxi. (1886) 78 pp. (8 pls.). See Bot. Centralbl., xxvii. (1886) pp. 1, 245–7. Cf. this Journal, v. (1885) p. 841.

† Amer. Naturalist, xx. (1886) pp. 552–3 (7 figs.).

‡ Journ. of Bot., xxiv. (1886) pp. 193–6, 237–42 (1 pl.).

§ Journ. Quek. Micr. Club, ii. (1886) pp. 308–18.

plate, and that these plates show no sign of orifices, but only of thinnings over the cavities, except in abnormal cases where the organic cuticle has been partially or totally destroyed by accidental causes.

(*d.*) That the external membrane is in most cases so slightly silicious that even slight contact with acids promptly destroys it, and opens up the cavities at the back of it. That in other cases this membrane, which is generally thinner in the middle portion of the areolæ, does really occasionally become highly silicified, and may support particles of granules of highly refractive silica placed over the so-called "eye-spots," in which case the cavities must be hermetically sealed on both sides to all but osmotic influences.

(*e.*) That the lower closing membrane of the areolæ frequently carries various designs, the nature of which, on account of their minuteness, has not yet been well established, but which must depend upon structure, as no diffraction images produced by any organization lying at a lower level can be the cause of them, as no such lower organization exists below this bottom, or closing internal diaphragm.

(*f.*) That the thin upper membrane of the areolæ forms the extension of the edges of the so-called "nail-headed" bars which form the limiting walls of the areolæ as figured by Otto Müller, Flögel, Prinz, and Van Ermengem.

(*g.*) That the cavities in the valves are bounded by walls of solid silica. That these walls often extend beyond, above, or below the closing membranes of the areolæ, and that they frequently run into points or spines of various shapes and lengths, which project beyond the valve between the areolæ.

(*h.*) That the median slit or fissure, which is observed to run through the rachis, or thickened median line of most of the *Naviculæ*, is also closed top and bottom by a very thin organic slightly silicified membrane in recent normal valves. He believes, however, that minute apertures may exist in these narrow closing membranes in the neighbourhood of the central and of the terminal nodules; but this is a subject requiring further elucidation.

(*i.*) That the so-called "secondary" or internal valves—"Regenerationshülle"—of some diatoms do not exist in the very young valves, a fact which gives us the reason why the frustules which are formed of an old and of a younger valve, generally split up into an *odd* number of secondary valves, either three or five. It is his belief that the *young* secondary valves are always perforate at first, but as they grow older successive depositions of silica generally take place which end by obliterating the orifices, and in some cases fill these quite up by dense and projecting masses of silica of a higher refractive index than the substance proper of the surrounding shell, so as to appear as red or pink coloured granules on a greenish ground under the best immersion lenses.

(*k.*) That the connective zones or bands of some genera, such as *Isthmia*, are really and truly perforate.

(*l.*) That the so-called "areolæ," "beads," "pores," "orifices," "granular projections," "depressions," "hexagons," "moniliform

dots," "puncta," &c., of authors are all one and the same thing under varying microscopical interpretations, idiosyncrasies, or preconceived ideas.

Schmidt's Atlas der Diatomeenkunde.—Parts 23 and 24 of this work are published, and include eight plates of the genera *Auliscus*, *Aulacodiscus*, *Eupodiscus*, *Pyrgodiscus*, *Actinoptychus*, *Triceratium*, and *Trinacria*.

Alleged Fossil Algæ.*—In this memoir M. A. G. Nathorst replies to the objections raised by the Marquis of Saporta and MM. Lebesconte and Delgado, to the opinions previously published by the author, that many of the supposed fossil algæ are in reality nothing more than the tracks of animals, or phenomena of purely mechanical origin. The fossils whose nature is thus contested are commonly known as *Cruziana* or *Bilobites*, *Harlania*, *Eophyton*, and some other genera. They generally present themselves in demi-relief on the under surface of the beds in which they occur. No traces of organic substances are found associated with them, and they are composed of the same minerals as the matrix in which they are imbedded. The theory of their vegetable character rests on the peculiarity of their markings, which are supposed to be incapable of being produced by the tracks of organisms. Dr. Nathorst, however, shows that whilst it is difficult to understand how algæ would thus form casts in demi-relief on the under surface of the beds, such structures would be the natural results of the filled up tracks or burrows of marine organisms. Of the manner in which these could be made, the author gives practical proof by passing a movable roller, shaped like a double spindle, over the surface of a layer of soft mud, and then, by means of gypsum, obtaining moulds of the concave impressions. Photographs of these moulds are given in accompanying plates, and they faithfully represent in almost every detail the supposed algæ. The author by no means denies the probable occurrence of true algæ in Palæozoic strata, though he considers that most of the forms described as such by Saporta have no claim to be included in the vegetable kingdom.

Fungi.

Fungus-pigments.†—According to Herr E. Bachmann the substances which give the bright colour to fungi are of three kinds, viz. —(1) A product of excretion on the cell-wall or in the intercellular spaces; in *Paxillus atrotomentosus* and *Agaricus armillatus* this pigment is crystalline; in *Lenzites sæpiaria* of the nature of a resin. (2) A pigment colouring the cell-wall itself; of this description are all those which give the brown, red, or red-brown colour to the apothecia of lichens. (3) A constituent of the cell-contents, as in the Uredineæ, Tremellini, and many species of *Peziza*, where an oily sub-

* Nathorst, A. G., 'Nouv. Observ. sur des Traces d'Animaux et autres Phénomènes d'origine purement méchanique décrits comme "Algues Fossiles,"' 5 pls. and numerous figs., Stockholm, 1886. See Geol. Mag., 1886, pp. 409-10; also Prof. W. C. Williamson in Nature, xxxiv. (1886) p. 369.

† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 68–72.

stance serves as the matrix. The characteristic reaction is a blue colour with sulphuric acid, and green with potassium biniodide. To this class belongs also the red pigment in the latex-tubes of *Lactarius deliciosus*, while the green colour of the pileus is due to a pigment of the second description. Coloured substances occur also in the hyphæ of many fungi.

In about 30 species of fungus, the author found seven red, three violet, and five yellow pigments. The number appears to be greater than in the petals of flowering plants. Many species seem to be distinguished by a specific pigment, while other colouring matters are common to several species of a genus or to a number belonging to different genera.

Edible Fungi.*—Herr C. J. Mörner has made a careful estimation of the nitrogenous contents of the various edible fungi, distinguishing between those albuminous constituents which are, and those which are not digestible. The result is materially to reduce the nutritious properties of these plants below the estimate previously held. The fungi containing the largest proportion of digestible albuminoids are *Agaricus campestris*, 22·3 per cent. of the dry weight, *Lycoperdon bovista*, 19·2 per cent., and *Agaricus procerus*, 18·7 per cent.; next to these come *Morchella esculenta* and *Boletus edulis* and *scaber*. In these species the indigestible albuminoids vary from 4·0 to 16·7 per cent.; while in some other species they are considerably in excess of the digestible nitrogenous constituents.

Structure and Development of Ascomycetes.†—Herr H. Zukal describes the fructification of *Thelebolus stercoreus*, growing on hare's dung, and determines that it belongs to the Ascomycetes rather than the Gasteromycetes, placing it among the Erysipheæ near to *Podosphæra*. It is distinguished by the yellow colour of the perithecia which burst when placed in water, the single ascus being projected into the air. The mechanism of expulsion is as follows:—At the base of the sporiferous sac is an accumulation of substance capable of absorbing a great quantity of water; the water enters this through the upper part of the membrane of the ascus, which is very permeable; the ascus in consequence increases greatly in volume and bursts the perithecium. The ascus is also remarkable for the great number of spores which it contains (probably 8 × 64).

From a study of the development of the fructification of *Ascodesmis nigricans*, *Hyphomyces rosellus*, *Chætomium crispatum*, and *Eurotium herbariorum*, Zukal draws conclusions opposed to the sexuality of the Ascomycetes.

In *Eurotium herbariorum* he finds asci developed quite independently of the archicarp and pollinodium, described by de Bary as the sexual organs.

Ascodesmis nigricans, which grows on dogs' excrements, Zukal regards as a transitional form between the Gymnoasci and the

* Bot. Sekt. Naturvet. Studentsällsk. Upsala, April 13, 1886. See Bot. Centralbl., xxvii. (1886) p. 130.

† Denkschr. Math.-naturwiss. Classe Akad. Wiss. Wien, 1885. See Bull. Soc. Bot. France, xxxiv. (1886) Rev. Bibl., p. 51.

Discomycetes; and here again he finds, whenever the nutrient fluid is nearly exhausted, asci springing directly from the hyphæ. Conidia were also observed at the periphery of the groups of asci, or sometimes replacing them, indicating that they are abortive asci. In *Chætomium crispatum* he finds the perithecia and sclerotia to have the same origin; sclerotia may, in fact, in certain cases, take the place of perithecia.

Zukal recommends the following mode of culture for these Ascomycetes. The reticulate spores of *Ascodesmis* were made to germinate in a decoction of plums, into which was introduced a small quantity of dog's excrements; this insured the production of asci. In the case of *Chætomium* the same result was obtained by the addition of very thin slices of potato.

Richonia, a new genus of Pyrenomycetes.*—M. E. Boudier describes under this name a new hypogæous genus of Perisporiaceæ, near to *Zopfia* :—Perithecia semper repleta, firma, sparsa, superficialia, carbonacea, astoma, supra rotundata, subtus depressa, intus grumosa. Thecæ clavatæ, crassæ, 2–6-sporæ, mox resolutæ. Sporæ majores, didymæ, loculis rotundatis obtusæ, ad septam constrictæ, primo lævos, hyalinæ, guttulatæ, dein filamentosæ, marcescentes olivascentes, denique maximæ, aterrimæ, rugulosæ, et difformes. Paraphyses numerosæ, tenues, ramosissimæ et intricatæ, thecas et sporas circumdantes. The only species, *R. variospora*, is parasitic on the roots of asparagus.

M. Boudier also describes the following new species :—*Nectria* (*Lasionectria*) *Mercurialis*, on dry stems of *Mercurialis perennis*; *Ophionectria Briardi*, on rotten wood, old Sphæriaceæ, &c., *Torubiella* (*Cordicipitis*) *aranicida*, on dead spiders.

Cucurbitaria Laburni on Cytisus Laburnum.†—The structure and biology of this parasite on the laburnum are described at length by Freiherr v. Tubeuf. It is found chiefly on the dead boughs, apparently not attacking those that are green and healthy. The perithecia have a thick pseudo-parenchymatous dark peridium, which is warty on the outside, and has a distinctly depressed opening; it is about 523 μ long by 407 wide. The nucleus is composed of long, stout, often branched paraphyses, between the long cylindrical asci which are always rounded at the end, and are about 121 μ long by 21 μ broad. Each ascus contains normally 8 spores, but these spores may divide further or become changed into groups of spores or sporidesmia; these sporidesmia are 28–36 μ long by 14 wide. The pycnidia are of two kinds, larger and smaller; the gonidia contained in them differing also in size and colour.

The ejection of the ascospores takes place in a peculiar way. The ascus consists of a double membrane, of which the inner portion is much more elastic than the outer; these inclose the protoplasmic sac

* Rev. Mycol., 1885 (1 pl.). See Bull. Soc. Bot. France, xxxiii. (1886) Rev. Bibl., p. 62.

† Bot. Centralbl., xxvi. (1886) pp. 229–33, 278–81, 310–3, 352–7; xxvii. (1886) pp. 23–7, 74–7, 123–8, 173–9 (2 pls.).

in which the ascospores are imbedded, and which is very elastic and capable of swelling. By rapid absorption of water, the inner protoplasmic sac swells rapidly, bursts the outer membrane of the ascus, and is suddenly ejected. The ascospores and the pycnogonidia can all be made to germinate in nutrient solutions.

The parasitism of *Cucurbitaria* possesses the peculiarity of inciting in the wood of the laburnum the formation of new vascular bundles, on the bast side of the old bundles. In nature the infection takes place chiefly in those spots on the branches which have been injured by hailstones.

On dead branches of *Sorbus Aucuparia*, the author finds a second species of *Cucurbitaria*, which he names *C. Sorbi*.

Entomophthoreæ.*—Dr. E. Eidam gives a more detailed description of his new genus *Basidiobolus* † belonging to this class of fungi, and mentions a second species, *B. lacertæ*, found on the excrements of a lizard.

He takes the opportunity of revising the position of the class, and the diagnoses of its seven genera, *Empusa*, *Lamia*, *Entomophthora*, *Tarichium*, *Completoria*, *Conidiobolus*, and *Basidiobolus*. In opposition to Brefeld, he places the family in the Zygomycetes rather than in the Oomycetes, and in close proximity to the Mucorini, with which it is related through *Piptocephalis* and *Syncephalis*. The mode of formation of the resting-spores of the Entomophthoreæ shows much greater analogy to that of the zygospores in this family than to that of the oospores in the Peronosporeæ. *Basidiobolus* differs from the rest of the Entomophthoreæ in entire rows of simple mycelial cells being simultaneously transformed into gametes, while in the other genera conjugation takes place only on special hyphal branches.

Entomogenous Fungus.‡—Mr. W. Fawcett describes, under the name of *Cordyceps lloydii*, a new species of remarkable fungus growing on an ant (*Camponotus atriceps*), which appears to have been attached during life; the capitate stroma grows out between the head and thorax, and a long filament springs from between the thorax and abdomen.

Melasmia Empetri, a new parasite on Empetrum nigrum.§—Herr P. Magnus has detected on this plant a fungus-parasite which causes the branches to elongate and to become comparatively bare of leaves. The sterigmata occupy the entire inner surface of the pycnidia; they are unbranched, and from them are abstricted conidia 12·2–17 μ long and 3·66–4·88 μ broad, somewhat constricted in the middle. The ascus-form of the fungus probably belongs to the Hysteriaceæ, but has not yet been detected.

Parasitic Fungus of the Roots of Orchideæ.‖—The "yellow lumps" on the rhizome of *Neottia nidus-avis* and on the underground

* Cohn's Beitr. zur Biol. der Pflanzen, iv. (1886) pp. 181–251 (4 pls.).
† See this Journal, *ante*, p. 294.
‡ Ann. and Mag. Nat. Hist., xviii. (1886) pp. 316–8.
§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 104–7 (3 figs.).
‖ Bot. Ztg., xliv. (1886) pp. 481–8, 497–505 (1 pl.).

stems and roots of other orchids have long been known, and have been variously interpreted by different observers. Herr W. Wahrlich has examined these organs in *Orchis maculata*, *Gymnadenia albida*, *Platanthera bifolia*, *Ophrys muscifera*, *Epipogon aphyllum*, *Serapias lingua*, *Goodyera repens*, *Corallorhiza innata*, and in about 500 exotic orchids, and found them all more or less infected by a parasitic fungus, the hyphæ of which are densely interwoven round a body of the nature of a haustorium. Fructification of the kind designated *Fusisporium*-spores was observed, as well as megalospores, and, in the case of *Vanda suavis* and *tricolor*, perithecia with ascospores. Differences in the thickness of the hyphæ, in the behaviour of the haustoria to chlor-zinc-iodide, and in the fructification, indicate probably a variety of species of parasitic fungus, but all included in one group belonging to the Pyrenomycetes. The perithecia of the species parasitic on the two *Vandæ* are of a bright red colour, isolated or in small groups of two or three on a moderately developed reddish-brown stroma, which however seldom emerges from the tracheids; when it does so it consists of a strong compact weft of hyphæ. The asci contain eight spores arranged in an oblique row; the ascospores are elliptical, two-celled, and constricted in the middle. These characters seem to determine the fungi in question to belong to the genus *Nectria*, of which the author establishes two new species, *N. Vandæ* on *Vanda suavis*, and *N. Goroshankiana* on *V. tricolor*.

New Uredineæ parasitic on Himalayan Coniferæ.* — Dr. A. Barclay describes a species of Uredineæ parasitic on *Abies smithiana* in the Himalayas, possibly identical with the *Æcidium Thomsoni* gathered by Dr. Thomson. It occurs in great abundance throughout the forests of the Sutlej valley, at elevations of from 7000 to 10,000 feet. The author met with it during May, and believes that it disappears entirely during the rains of July. It occurred in two forms, which he describes as the æcidial and uredinal, found on the same host-species, though often on different individuals; but he was not able actually to demonstrate the genetic connection between them. No form corresponding to the teleutosporal was observed. The æcidial form causes a real or pseudo-hypertrophy in the tissues, with a pale yellow colour, always attacking a young terminal shoot. The spermogonia occur in great numbers; they are deeply set with their bases beneath the hypoderma, and measure about 0·139 mm. in length and breadth, the conical neck protruding 45 μ above the level of the epidermis. The æcidiospores are long irregularly oval bodies, measuring when dry about 38 by 16 μ, and are densely beset with minute spines or tubercles. The uredinal form is much more frequently met with than the æcidial. The uredospores are spherical, and, when moistened, measure on an average 9·5 μ in diameter; they are entirely destitute of surface-markings.

A second species is described, also growing on *Abies smithiana*, of which the æcidial form only was observed. It attacks only a few "needles" in a shoot, instead of the whole shoot, as in the previous

* Journ. Asiatic Soc. Bengal, lv. (1886) pp. 1–11, 140–3, 223–6 (5 pls.).

instance. The æcidiospores are mostly oval, varying between 24 by 24 μ and 34 by 22 μ; the epispore is covered with prominent deciduous spines, which sometimes become detached in flakes.

A third species, of which also only the æcidial form is described, is parasitic on *Cedrus deodara*. The affected "needles" are not discoloured, but retain their normal green colour, though they fall early. The spermogonia are very minute, about 0·081 mm. in breadth by 0·045 in depth, and are for the most part above the level of the epidermis. The æcidiospores are spherical or oval, with orange-yellow granular contents, measuring, when dry, about 12·7 by 8·4 μ; the epispore is very thick, and is beset with numerous prominent tubercles. No names are proposed for the last two species.

Sclerotinieæ and Sclerotium-diseases.*—Prof A. de Bary gives an exhaustive account of the structure and development of the two forms of *Peziza sclerotiorum* Lib. (*Sclerotinia Libertiana* Fkl., *Rutstromia* Karst.), the sclerotium-producing mycelium, and the fructification. The conditions for the production of the latter form are sufficient moisture and warmth. Sclerotia which had been kept dry for three years were found to be still capable of development; from one to as many as twenty apothecia may be produced from a single sclerotium. The hyphæ exhibit Errera's glycogen-reaction very beautifully.

Peziza sclerotiorum must be regarded both as a saprophyte on decaying and as a parasite on living vegetable organisms; but in the latter case the process of infection is different from what has hitherto been supposed. The spores put out germinating filaments when placed on living organisms; but these remain short, and do not penetrate into the tissues; the fungus becomes capable of infection only when these filaments have obtained a certain development from saprophytic nutriment in a nutrient solution or a dead plant. Free access of air is absolutely essential for its development; it is nearly indifferent to the action of light.

With the growth of this fungus is closely connected the formation of a large amount of oxalic acid; when grown in a nutrient solution containing a lime-salt, the older hyphæ become encrusted with calcium oxalate. The oxalic acid is the result of the oxidation of carbohydrates, and its formation can be shown to take place especially in the immediate vicinity of the fungus-hyphæ; whether in the hyphæ themselves or not, the author has not at present been able to determine. The irritation caused by the resistance of a solid body to the growth of the hyphæ promotes the formation of tufts of organs of attachment, from which is excreted a fluid which penetrates into the adjacent living cells and kills them. These dead cells then produce other fluids which serve as nutrients to the fungus. The parasite, in fact, poisons the living host, and the products of poisoning serve as nutrient materials for its own further development. When it has once entered the living host the mycelium developes with great rapidity; first of all destroying the protoplasm of the living cells, then the middle

* Bot. Ztg., xliv. (1886) pp. 377–87, 393–401, 409–26, 433–41, 449–62, 465–74 (1 fig.).

lamella of the cell-walls, and partially also the rest of the cellulose. The destruction of the cell-walls is brought about directly by a ferment, that of the protoplasm either by a ferment or by acids or salts dissolved in the cell-sap.

The *Peziza* does not attack all plants alike; those especially liable are species of *Petunia*, *Phaseolus vulgaris*, *Zinnia elegans*, and *Daucus*; species of *Helianthus* and *Solanum tuberosum* to a less degree.

The sclerotium of the hemp, caused by a species named by Tichomirow *P. Kauffmanniana*, is apparently identical with that of *P. sclerotiorum*, as also is probably that of the rape. The sclerotium-disease which attacks cultivated clovers, especially *Trifolium pratense*, *repens*, *incarnatum*, and *hybridum*, appears to be due to a different species, *P. ciborioides* Fr. (*Sclerotinia Trifoliorum* Eriks.).

Diseases of Crops.*—In the first part of an exhaustive work (in Swedish) on the diseases of crops, Herr J. Eriksson gives special descriptions of the following :—

1. Gall-formations on the roots of barley. This is due to the attacks of nematoids.

2. The rust of timothy-grass and oat. Caused by a fungus apparently identical with Fuckel's *Scolicotrichum graminis* parasitic on various grasses.

3. Rose-rust. The æcidial form of *Phragmidium subcorticium*.

4. Mildew. The most abundant form of rose-mildew in Sweden is *Sphærotheca pannosa*. *Podosphæra oxyacanthæ* is also extremely common on the hawthorn. *Uncinula Aceris* and *U. Tulasnii* occur on the maple. The conidial stage of an undescribed mildew attacks several species of *Erica*, e.g. *E. gracilis*, and is thus described :—*Oidium ericinum* n. sp. Hyphi conidiophori solitarii, 60–80 μ longi, folia et caules ubique incolentes. Sporæ ellipticæ, utrinque rotundatæ, 34–46 μ longæ, 12–16 μ latæ. On *Acacia Lophantha* the author finds a new and peculiar form of *Erysiphe Martii*.

5. The spot-disease of roses. Caused by *Erysiphe radiosum*.

6. Apple-scurf. *Fusicladium dendriticum*. Occurring both on the leaves and on the fruit. Pear-scurf is caused by *F. pyrinum*; cherry-scurf by a different species, which is thus described :—*Fusicladium Cerasi*. Hyphasma supra epidermidem cerasi effusum, maculas minutas orbiculares sericeas sordide cinereas in cute immersas sistens. Hyphi assurgentes flavescentes, simplices v. bifurci, tenuiter septati. Conidia subelliptica, utrinque acuminata, 18–22 μ longa, 4 μ lata, simplicia v. uniseptata.

7. Spot-disease on wild pears. Due to *Xyloma Mespili* DC. (*Morthiera Mespili* Fkl.).

8. Myrtle spot-disease. Caused by a new species, *Cercospora Myrti*. Maculæ epiphyllæ, subrotundæ, rufo-purpureæ. Cæspituli hypophylli, fasciculati, fusco-atri. Conidia longissima, curvula, versus apicem attenuata, cuspidata, fusca, 3–6-septata, 60–100 μ longa, 2–4 μ lata.

* Eriksson, J., 'Bidrag till kännedomen om våra odlade växters sjukdomar,' No. 1, 85 pp. and 1 pl., Stockholm, 1885. See Bot. Centralbl., xxvi. (1886) p. 335.

Tubercles on the Roots of Alnus and the Elæagnaceæ.*—In order to establish that the bacteroid found in the tubercles on the roots of these plants is peculiar to them, Dr. J. Brunchorst has carefully examined the corresponding structures on the roots of *Cratægus prunifolia*, *Cyperus flavescens*, *Juncus bufonius*, *Æsculus Hippocastanum*, *Cycas*, *Ceratozamia*, and other Cycadeæ, without finding any organisms bearing the remotest resemblance to those found in *Alnus*, *Elæagnus*, *Hippophae*, and *Shepherdia*. The structures in the parasitic fungus, hitherto regarded as spores, the author now regards as sporangia, the contents of which break up, late in the summer, into spores of extreme minuteness. Herr Brunchorst proposes for the parasite the name *Frankia subtilis*, probably identical with Woronin's and Frank's *Schinzia*, and Müller's *Plasmodiophora*. He now regards it as belonging to the Hyphomycetes, but with a mode of formation of its spores peculiar to itself.

Protophyta.

Physiology and Morphology of Alcoholic Ferments.†—Herr E. C. Hansen devotes the latest instalment of his treatise on this subject to the methods of obtaining pure cultures of *Saccharomyces* and other similar organisms. He states that the formation of pellicles (Kahmhautbildung) is a general phenomenon with all micro-organisms, both with bacteria and with true fungi. It takes place with all forms of *Saccharomyces* when the cells stand for a sufficient time with their fermenting nutrient fluid. Under these conditions *S. cerevisiæ* and *S. ellipsoideus* are transformed into *S. Pastorianus*, and a development sets in of filiform and bacterioid cells. One condition for this development is an abundant access of atmospheric air. It commences at from 13°–15° C.

Abnormal Secretion of Nitrogenous Substances by Yeasts and Moulds.‡—According to MM. U. Gayon and E. Dubourg, when yeast is suspended in water, only a small quantity of nitrogenous matter passes into solution, and this is not coagulable by heat. If the water is replaced by concentrated solutions of such salts as potassium acetate, oxalate, or iodide, sodium phosphate or sulphate, calcium chloride, magnesium sulphate, tartar emetic, &c., the liquid dissolves a considerable quantity of albuminoids which are either partially coagulable by heat and acids or not coagulable at all. The total amount of albuminoids dissolved, and the ratio between the coagulable and non-coagulable portions depend on the nature of the saline solution. After the yeast has been treated with these solutions, it can still yield to water a considerable quantity of albuminoids, partly coagulable and partly non-coagulable. Many other soluble substances behave in the same way as the above salts. If yeast is

* Unters. a. d. Bot. Inst. Tübingen, ii. (1886) pp. 151–77 (1 pl.). See Bot. Centralbl., xxvii. (1886) p. 109. Cf. this Journal, *ante*, p. 272.

† Meddel. Carlsberg Labor., ii. pp. 152–210 (8 pls. and 4 figs.), with French résumé. See Bot. Centralbl., xxvii. (1886) p. 163.

‡ Comptes Rendus, cii. (1886) pp. 978–80.

previously treated with methyl, ethyl, propyl, or octyl alcohols, glycol, or glycerol, it yields to water coagulable albumin, but if treated with isopropyl alcohol, or butyl or isobutyl alcohol, it yields only non-coagulable albumin to water.

The yeast which has been deprived of its nitrogenous matter is greatly modified in appearance, dimensions, and vitality. Sometimes it is killed, but in many cases it revives easily when placed in saccharine musts. The abnormal secretion of nitrogenous substances under the influence of strong saline solutions is correlative with an increased production of soluble ferment. All the varieties of yeast which produce inversion behave in the same way, and give an abundant secretion of albumin and invertin or sucrase, but those which do not cause inversion behave quite differently, and yield no more albumin to saline solutions than to pure water. The same behaviour is observed in the case of inversive and non-inversive moulds.

It would seem, therefore, that the inversive power of a yeast or mould is intimately connected with the readiness with which its membrane permits the passage of albuminoids.

Gum-ferment in Barley and Malt.*— Herr J. Gaunersdorfer finds the "gum-ferment" of Wiesner† in various kinds of barley and malt, especially in the testa, the parenchyma of the pericarp, and in the bast-fibre-like elements of the paleæ. In malts, Wiesner's characteristic reaction for this substance, a blue precipitate with orcin and hydrochloric acid, is obscured by the malt-diastase being coloured red, brown, and finally yellow, by the same reagents.

Acetic Ferment which forms Cellulose.‡ — Mr. A. J. Brown obtained pure cultivations of the peculiar acetic ferment known as the "vinegar-plant" or "mother" (for which he suggests the name *Bacterium xylinum*) by a combination of the frictional and dilution methods, and by growing it on solid gelatin. The plant gives rise to a membranous growth, in all sorts of conditions, a form which *B. aceti* never assumes. Moreover, *B. xylinum* gives all the reactions of cellulose, which the former does not. The fermentative actions are similar in the two forms. When treated with H. Müller's bromine method, the membranous growth leaves a film of pure cellulose. Experiments show that the vinegar-plant forms its cellulose from dextrose; neither cane-sugar, starch, nor ethylic alcohol are converted into this substance. The plant gives rise to a double action, viz. the production of gluconic acid, and the formation of cellulose. Mannitol and lævulose are also converted into cellulose by this plant.

Microbe of Nitrification.§—M. J. B. Schnetzler collected the efflorescence of calcium nitrate on a wall exposed to nitrogenous

* Allg. Zeitschr. f. Bierbrauerei u. Malzfabrication, 1886, Nos. 3 and 4. See Bot. Centralbl., xxvii. (1886) p. 39.

† See this Journal, *ante*, p. 106.

‡ Journ. Chem. Soc. Lond., xlix. (1886) pp. 432–9.

§ Arch. Sci. Phys. et Nat., xvi. (1886) pp. 73–4.

exhalations, and dissolved in distilled water. A drop of this water placed on sterilized gelatin developed the next day great quantities of a minute globular microbe, about 1 μ in diameter, which swarmed rapidly in the water, and displayed the closest resemblance to *Bacterium Fitzianum* Zopf, which converts glycerin into ethyl-alcohol. It is always accompanied by a number of other forms, especially *B. subtile*.

Organisms of Sulphuretted Waters.* — M. L. Olivier has examined the vegetable organisms in a number of sulphuretted springs in different parts of France, and finds bacteria present in all of them without exception, having the power of retaining their vitality up to at least as high a temperature as 50° C. In cold springs these organisms are of the nature of leptothrix, the filaments of which contain granulations of sulphur reduced out of the water. In the hot springs the organisms might rather be described as bacilli of extreme tenuity, varying on the one hand to the form of micrococcus, on the other hand to bacterium; they are all immotile. These also serve as accumulators of sulphur, which is found in the glarous mass in a crystalline state, and is contained also in their protoplasm.

Microsporon furfur, the pathogenic Microbe of Tuberculosis.†— MM. Duguet and J. Héricourt find this microbe to be a universal accompaniment of tuberculosis, whether the ordinary bacilli are present or not, and its injection into rabbits invariably caused this disease. The bacillus of tuberculosis is regarded by the authors as a micro-organic form, corresponding to one of the phases in the evolution of *Microsporon furfur*.

Some cases of acute tuberculosis examined by these investigators presented no bacilli or zoogloea forms; but when the tissues were treated with potash (10 to 40 per cent.), a delicate mycelium allied to that of *Microsporon* was discovered; and on pushing the inquiry further it was found that this mycelium was more frequently present than the bacilli, being seen not only in the tubercles, but also in the neighbouring healthy tissue. Similar mycelial threads can also be found in the expectoration mixed with the bacilli. The cultures of *Microsporon furfur* from tubercle produced from the fungus, and those from tubercles of man are precisely the same in character. Cultivations can be made in slightly alkalized bouillon or in milk, when it becomes possible to distinguish an aërobic and an anaërobic element. The former floats at the surface, and at a temperature of from 86–100° Fahr. forms a thick membrane composed of bacilli. The latter is found at the bottom of the cultivation-tube as a mass of granulations and mycelium. MM. Duguet and Héricourt believe they can obtain an attenuated virus.

Typhus-bacillus.‡—Dr. A. Pfeiffer has isolated the bacillus found in the stools of typhus-patients by cultivation in agar-agar-flesh-peptone jelly, in which they made their appearance on the second or

* Comptes Rendus, cii. (1886) pp. 556–9. † Ibid., pp. 943–6.
‡ Deutsch. Med. Wochenschr., No. 29, 1885. See Bot. Centralbl., xxvii. (1886) p. 15.

third day after infection. They were more sharply defined in 1 per cent. agar-agar than in the gelatin sown with pure cultures from the mesenteric glands of typhus-patients. The colonies had moderately sharp outlines, were slightly and uniformly granulated, of a light brown colour, rarely spherical, but irregularly scooped out or pear- or lemon-shaped. In suspended drops the bacilli had an active spontaneous motion, and formed long mucilaginous threads. In dry preparations, coloured with alkaline solution of methyl-blue, they exhibited the characteristic length and breadth of the typhus-bacillus, and especially the abundant formation of vacuoles observed by Gaffky.

The same bacillus was found also in the intestines of the corpses of typhus-patients, but nowhere except in the human body.

Bacteria in the Blood of Living Animals.*—Herr J. v. Fodor has examined the blood of healthy living or recently killed animals for the purpose of ascertaining if bacteria develope.

The blood, placed in sterilized flasks with the usual precautions, was kept at the temperature of the room, or in incubators at 35° to 37° C. for several weeks, and, after excluding errors from accidental impurities, the author found that the blood of healthy animals contained no bacterial germs capable of development. It was also found that the blood of diseased animals, provided that the vascular system remained uninjured, was free from bacteria.

The author furthermore injected non-pathogenic bacteria (*B. termo*, *B. megatherium*, *B. subtilis*) in enormous quantities into the jugular veins of living rabbits, and found, in consonance with the results of other observers, that the injected bacteria disappeared from the blood within a short time (occasionally four hours), that is to say, they were not able to be demonstrated microscopically, nor after cultivation in peptonized gelatin.

Phosphorescent Bacterium.†—Herr J. Nüesch records an instance of a bacterium so strongly phosphorescent with a green light, that people standing round could recognize each other's features, and accurately observe the position of the minute-hand, and even of the second-hand of their watches.

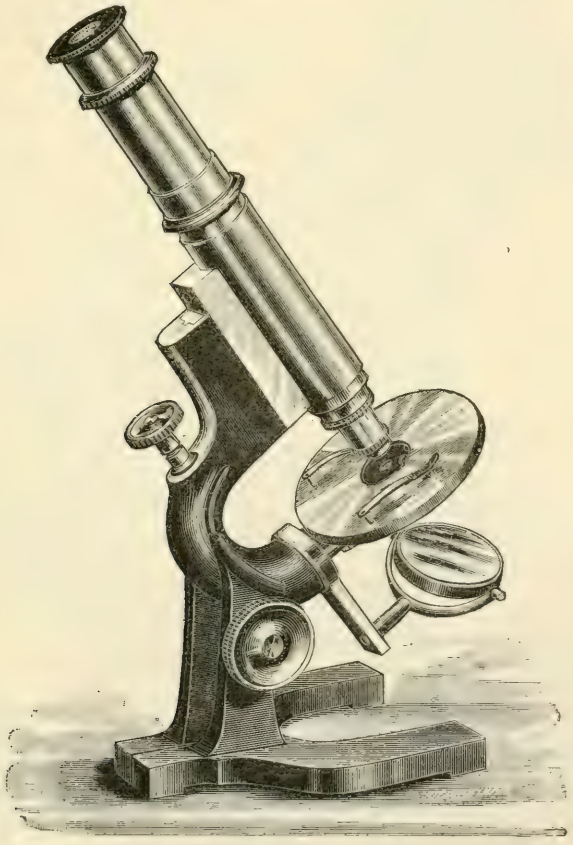
* Arch. f. Hygiene, iv. (1886) p. 129.
† Helvetia, 1885. See Bot. Centralbl., xxvii. (1886) p. 161.

MICROSCOPY.

a. Instruments, Accessories, &c.*

Bausch & Lomb Optical Co.'s New Student Microscope.†—The Bausch & Lomb Optical Co. have issued the low-priced Microscope for students shown in fig. 201. It is constructed on the Wale principle

Fig. 201.

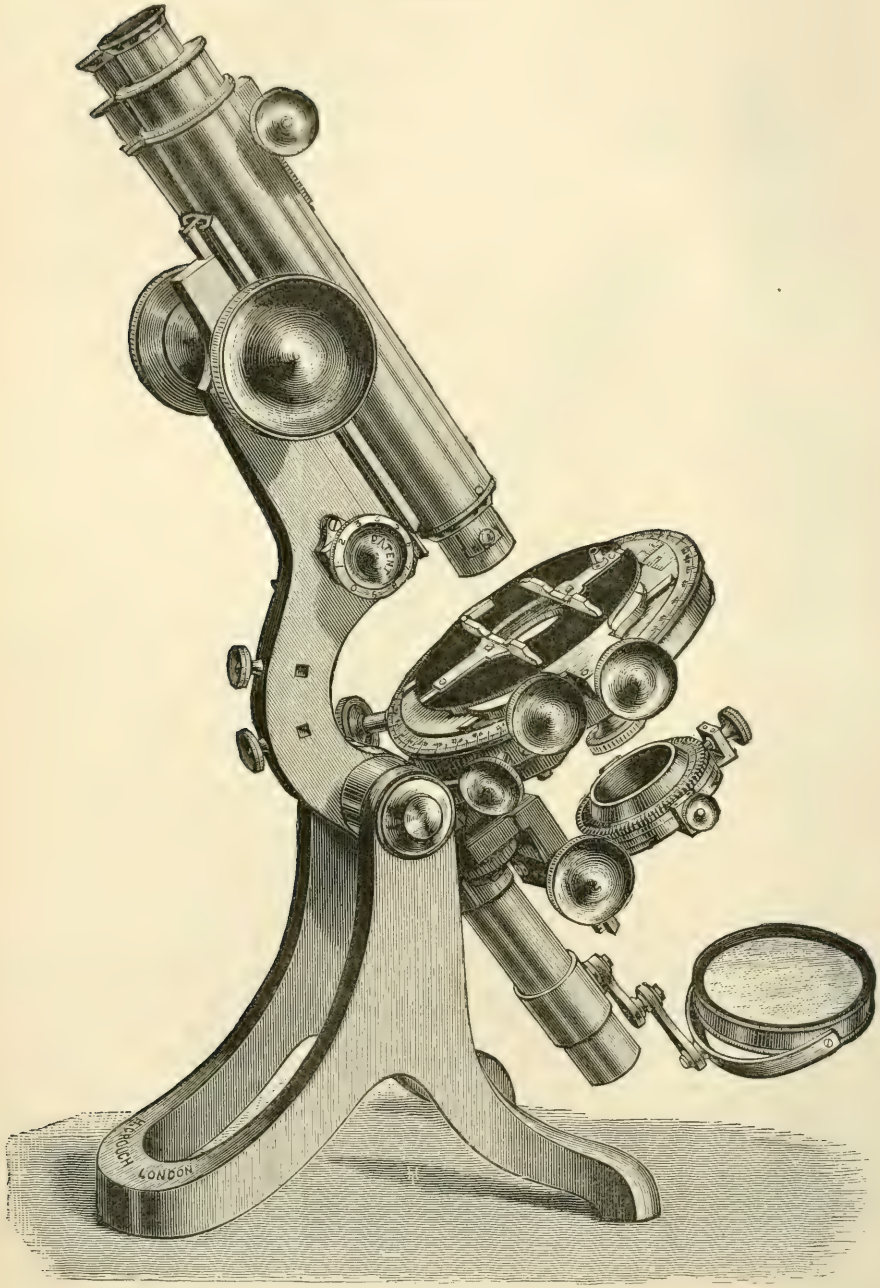


of concentric inclination of the arm, by which the instrument becomes more firm the further it is inclined. It also has a new roller

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

† The Microscope, vi. (1886) p. 199 (1 fig.).

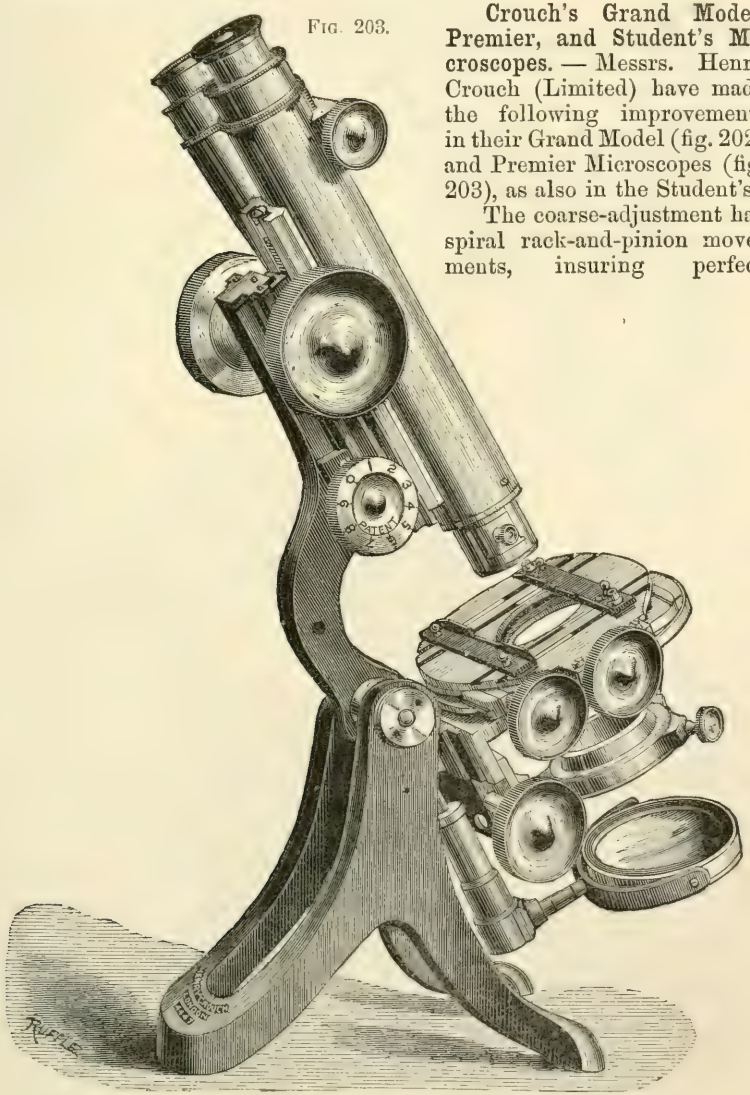
FIG. 202.



CROUCH'S GRAND MODEL MICROSCOPE.

motion for the fine-adjustment, and a revolving diaphragm fixed to a separate arm so that it can be swung out of the optic axis. The concave mirror is attached to a bar, the axis of which lies in the plane of the stage, so that illumination may be directed on the object from any point below or above the stage. The base and arm are japanned, the latter being fastened at any desired angle by means of milled heads in the pillars.

Fig. 203.



Crouch's Grand Model, Premier, and Student's Microscopes. — Messrs. Henry Crouch (Limited) have made the following improvements in their Grand Model (fig. 202) and Premier Microscopes (fig. 203), as also in the Student's.

The coarse-adjustment has spiral rack-and-pinion movements, insuring perfect

Fig. 204.

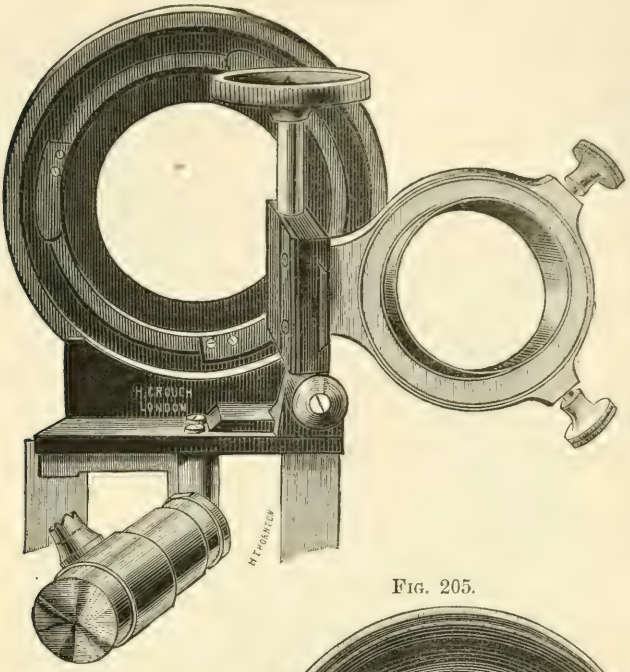
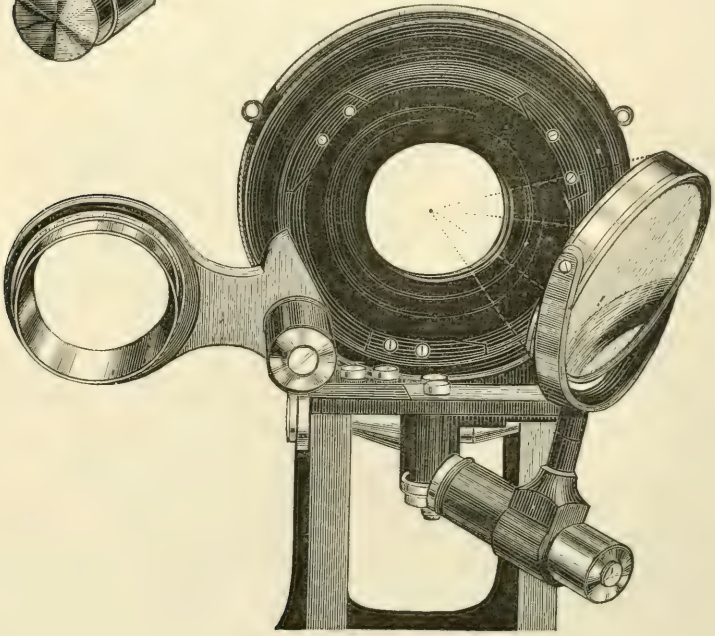


Fig. 205.



smoothness and steadiness of focusing, and can be used alone for focusing all powers up to 1/6 in., while the fine-adjustment is claimed to be of the "greatest possible delicacy and stability, the most perfect arrangement yet applied to the Jackson model form of Microscope."

The substage (figs. 202, 203, and 204) is hinged so as to give increased facility for inserting and removing illuminating accessories. It can also be entirely removed by a lateral slide when required.

The mirror-stem in the Premier and Student's Microscopes (figs. 203, 204, and 205) is pivoted from the attachment to the limb, so that it can be brought up level with or above the stage in a more convenient manner for oblique illumination than with the crank arm.

Cutter's Cam Fine Adjustment.*—Dr. E. Cutter has for years "sought to simplify the mechanism of the compound Microscope so that a really good instrument might be had for less money—not for the sake of doing away with the magnificent mechanisms now extant, but for paving the way for them by making Microscopes as plentiful and popular as pianos and organs." This contribution is one effort in this direction.

"Two ideas are involved: (1) To have a cam or cams at the distal end of the stage, which is a steel or brass plate fastened to the proximal end of the bed-plate of the stage; (2) To have four cams, one at each angle of the quadrangular stage, which is drawn down to the bed-plate by springs beneath, suggested by the late Dr. Elsberg.

The advantages of the cam fine-adjustment are:—

1. *Simplicity*, as compared with the screw fine-adjustment. A screw adjustment is a double-faced, projecting, spiral, inclined plane wound on a shaft. This plane runs on another re-entrant double spiral inclined groove winding around the inside periphery of a hole or shaft, usually fixed. For use on the stage the screw adjustment must not wabble, yet it must move readily and have no loss of motion upwards or downwards, inwards or outwards. Experience has taught that it takes a skilled mechanic to make a good fine screw adjustment. For ordinary screw threads the requirement is to bind in one direction, but not in the other direction. Such screw threads ill answer for moving backwards and forwards with the accurate delicacy of such an instrument of precision as the compound Microscope. It is expensive to make a fine screw adjustment, and there are few workmen that can make them.

On the other hand the cam adjustment is easily made by centering a metallic disc, outside of the true centre, on an axis of steel wire. It is simple to mount. Even an unskilled artisan can make and mount it.

2. *Cheapness.*

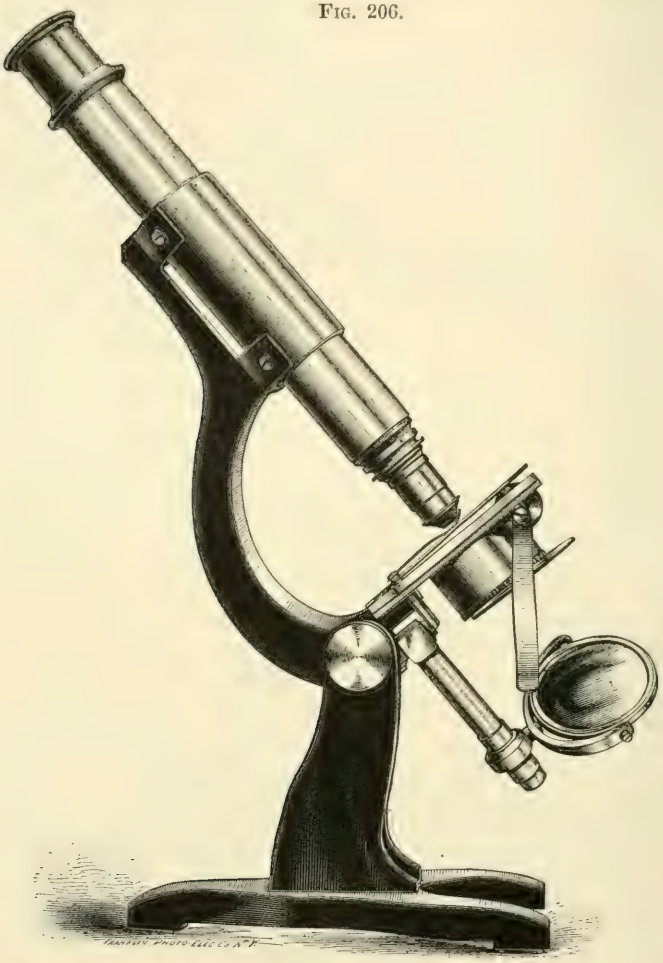
3. *Effectiveness.* No mechanical motion is so sure and effective. A short lever attached to the axis of the cam gives the means of applying required motions with ease and certainty. The amount of motion can be regulated exactly. It is rapid and sensitive.

4. *Not liable to get out of order*, as the spring or springs holding the

* The Microscope, vi. (1886) pp. 101–4 (1 fig.).

stage to the stage-plate keep the parts in contact together, and compensate for the loss by wear, which is on one surface in one direction, to wit, downwards, while the wear of the screw is on two surfaces in

Fig. 206.



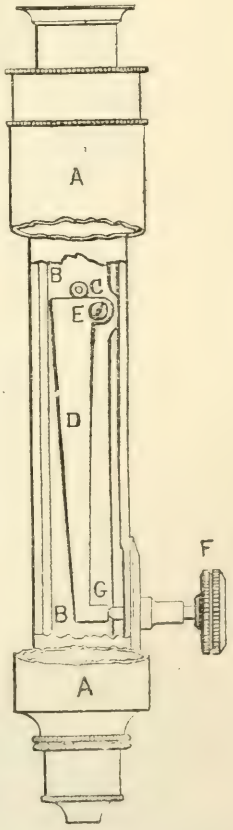
two directions, to wit, upwards and downwards. In the hands of an active worker this wear of a screw makes an unpleasant loss of motion in two directions, and which it is not easy to remove in the case of a screw. The cam gives the minimum of trouble for wear and loss of motion thereupon.

In fig. 206 the stage is represented as arranged for use, so that it can be elevated or depressed. When not in use the cam lever is turned so as to lie parallel with the stage, and the stage is not put on a stretch.

The author then discusses the objection that the inclination of the stage is a "barbarous" device, and says that he has used it successfully with objectives as high as a 1/10 in., but to obviate all annoyance from this objection, he has adopted Dr. Elsberg's idea of multiple cams, one at each corner of the stage; the two distal cams being on the same axis, and the two proximal cams on the same axis. A rod or rods connect the arm levers, and springs hold down the stage on the bed stage plate. The combined action of these cams gives horizontal motion.

Swift's Paragon Microscope (Wale's form).—In this Microscope (fig. 208) Messrs. Swift have adopted the form of inclining limb devised by Mr. George Wale, of the United States, which we have repeatedly described. The increased curve of the limb allows complete rotation of the mechanical stage. The centering and rotating substage is furnished with rack movement, on which it is applied by a dovetailed slide. The mirror, with gimbal, two arms, and rotating socket, slides on the tailpiece, which is hinged to swing laterally on the end of the limb.

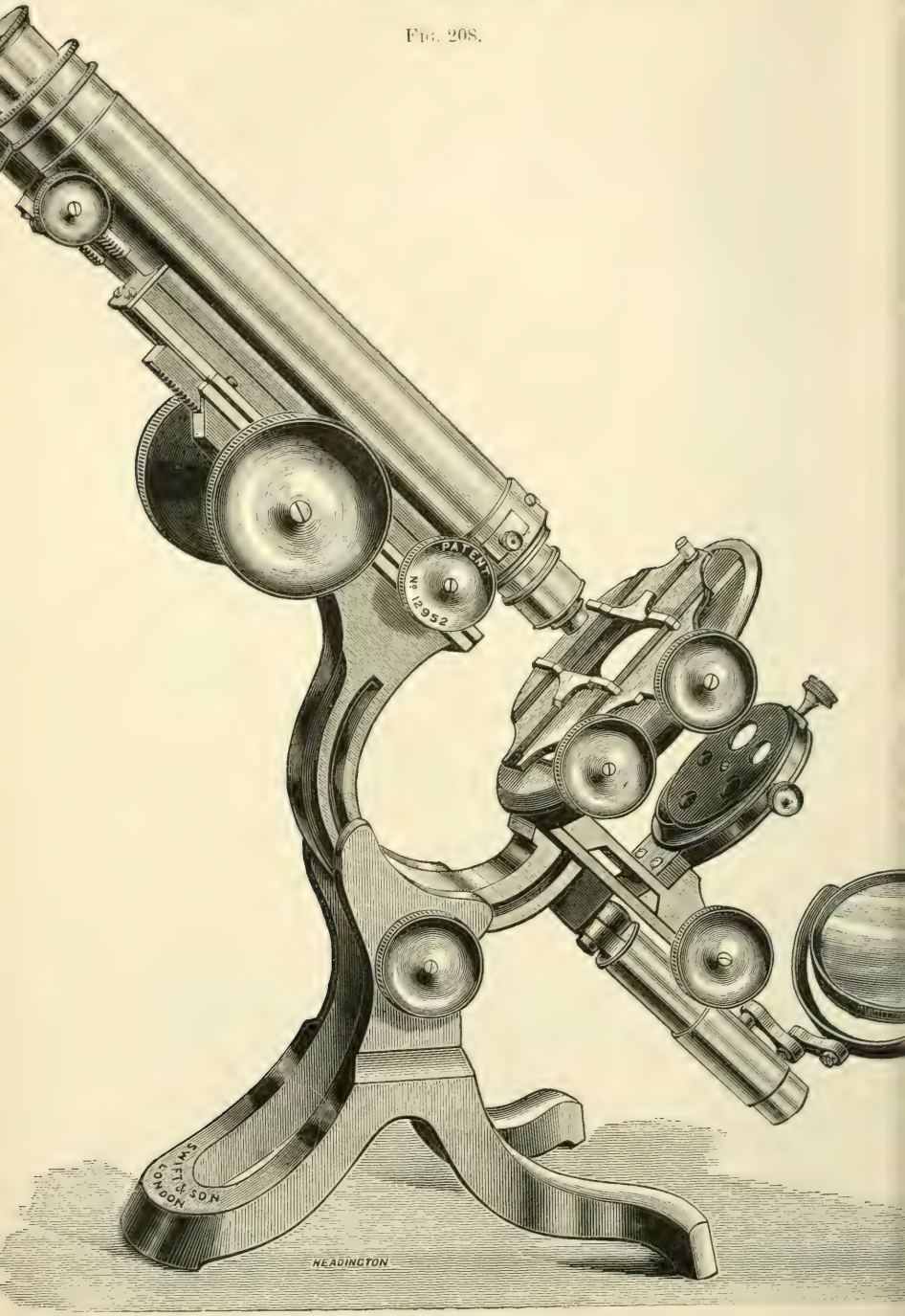
FIG. 207.



To this instrument Messrs. Swift have applied a new arrangement of fine-adjustment which they have patented. The mechanism is shown in fig. 207, where A A is the body-tube (the middle part cut away to show the action). This is connected at either end at the back with a chamfered slide, fitted to move accurately and lightly on the front of the coarse-adjustment slide B B of the usual "Jackson" form, a spiral spring above and at the back pressing it downwards. A long lever D is attached to the plate B B, to pivot at E; by the action of the milled head F, on the lower end G of the lever, the lifting stud C, connected with the chamfered slide behind the body-tube B B, is raised very slowly through a focusing range of about 1/10 in.; the reverse action of the screw allows the spiral spring above to press the slide downwards.

By this very simple mechanism the fine-adjustment is applied to the front of the coarse-adjustment, and acts on the whole body-tube, and not merely on the nose-piece, so that the magnification is not altered by changes in the focal adjustment. It is obvious that the slowness of the motion is here controlled by three factors: (1) the length of the lever D, (2) the distance of the lifting-stud C from the pivot or fulcrum E, and (3) the pitch of the screw-thread on F. We understand that Messrs. Swift anticipate being able to adapt this system of focusing to all their better class of instruments.

FIG. 208.



SWIFT'S PARAGON MICROSCOPE.

FIG. 209

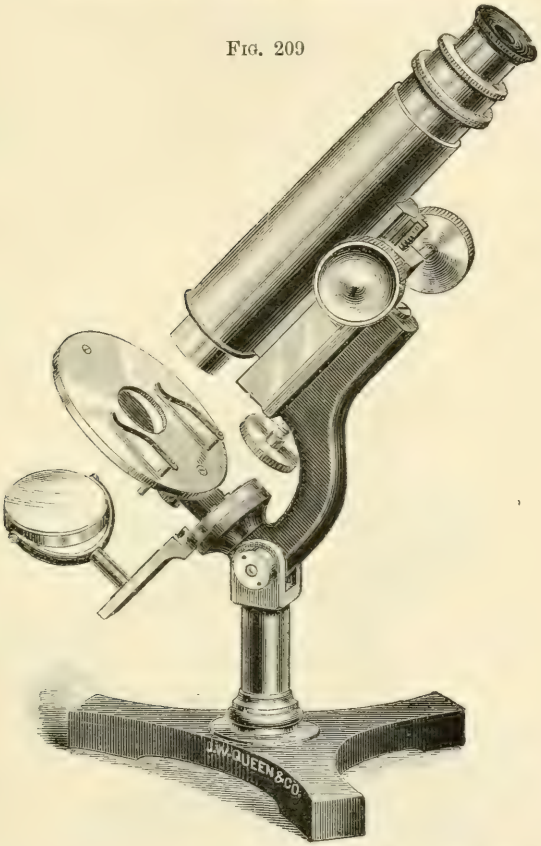
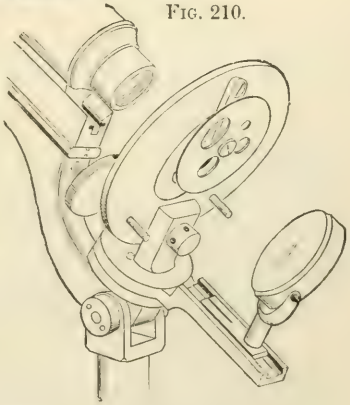


FIG. 210.



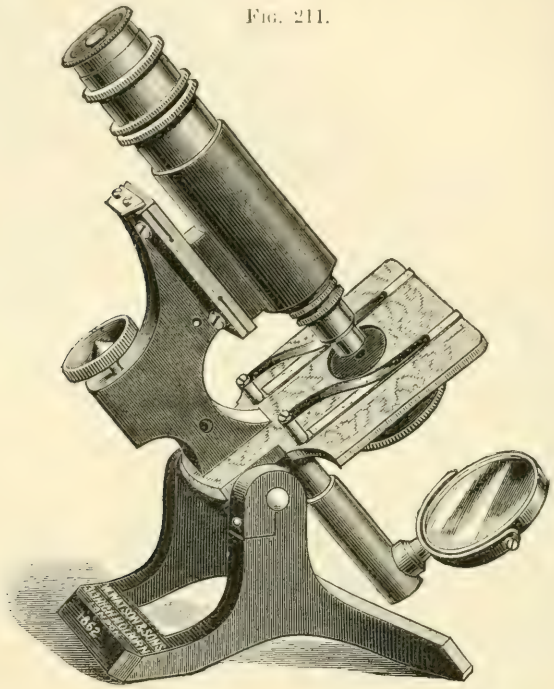
Queen's Acme No. 4 Microscope.*—Messrs. J. W. Queen & Co's. "Acme No. 4" Microscope (figs. 209 and 210) differs from the previous "Acme" models in having the fine-adjustment at the lower end of the straight part of the limb. The diaphragm is also on a hinged arm which may be readily swung aside when oblique light is required. The mirror arm slides in a groove in the swinging tail-piece.

* Micr. Bulletin (Queen's), iii. (1886) p. 17 (1 pl. and 1 fig.).

Watson's New Histological Microscope.—Messrs. W. Watson and Sons have designed this instrument for the use of class students, and it is sold at a very moderate price.

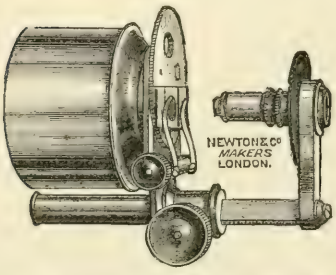
It has the fine-adjustment introduced by Messrs. Watson, and hitherto confined to the larger instruments, and also a novel feature

Fig. 211.



in connection with the stage which is so simple that it is a little remarkable that it has not been suggested before. This consists in adding to the stage two raised parallel ribs on which the object rests, and on which it can be readily moved about. The surface of the stage is thus kept free from scratches and, what is more important, friction is reduced to a minimum.

Fig. 212.



Newton's Microscopic Attachment for Lantern Projection.—This is a simple apparatus to screw on to the nozzle of any lantern in place of the front lens, and with the limelight it is claimed that it will show an ordinary microscopic slide on the screen 8 feet in diameter far more brilliantly and better defined

than the old forms of lantern Microscopes. It has a large rotating diaphragm forming an entirely open stage, which greatly facilitates the manipulation and gives a clean sharp edge to the disc. By a prism the image can be thrown down on paper for drawing. Any good Microscope objectives can be used.

For high power work it cannot of course compare with the Wright and Newton lantern Microscope.

Leeuwenhoek's Microscopes.—Leeuwenhoek, it will be remembered, published nearly the whole of his microscopical investigations through the medium of the Royal Society, and yet, beyond the occasional statement by himself that his observations were made with simple Microscopes, nothing appears to have been definitely known by his contemporaries regarding their actual construction. The

Fig. 213.

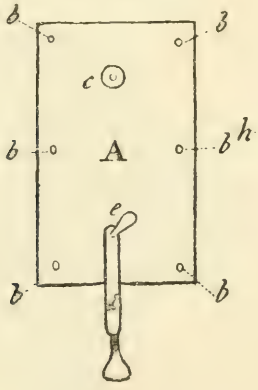
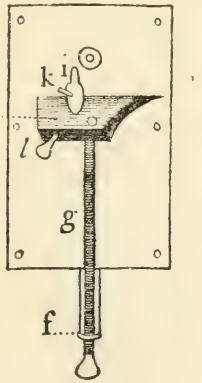


Fig. 214.



general impression during his lifetime seems to have been that he utilized lenses consisting of spherules of blown-glass. At his death (1723) he bequeathed to the Royal Society a cabinet containing twenty-six of his Microscopes (now lost), and these were reported upon * somewhat vaguely by Martin Folkes, Vice-President of the Royal Society, who appears not to have directed his attention minutely to their construction.

In 1740 these Microscopes were examined and described † to the Royal Society by Henry Baker, F.R.S., whence it appears that the magnifiers were not spherules of blown-glass, but bi-convex lenses having worked surfaces, and that they ranged in power from 1/5 in. to 1/20 in., magnifying from 40 to 160 diameters. No figure of any of the instruments was however published until 1753, when Baker ‡ issued two outline drawings representing both sides of one of them

* Phil. Trans., xxii. (1723) pp. 446-63. † Ibid., xli. (1740) pp. 503-19.

‡ 'Employment for the Microscope,' 1st ed., 1753, pp. 434-6, pl. xvii. figs. 7 and 8.

constructed of silver. These drawings are reproduced in figs. 213 and 214; but they do not give at all a clear idea of the construction of the instruments. It was therefore with much interest that we learnt that Prof. A. W. Hübrecht, of Utrecht, the eminent zoologist, was coming to London, bringing one of Leeuwenhoek's Microscopes, belonging to the Zoological Laboratory of the University of Utrecht. Unfortunately Prof. Hübrecht's visit was during the recess, so that there was no opportunity of exhibiting it to the Society, but by his courtesy we were enabled to make careful drawings and models of the instrument, the two sides of which are accurately shown in figs. 215 and 216, full size.

The lens is bi-convex, of about 1/4 in. focus, and is mounted between two concavities, provided with minute apertures, made in two corresponding thin plates of brass, which are held together by three

Fig. 215.

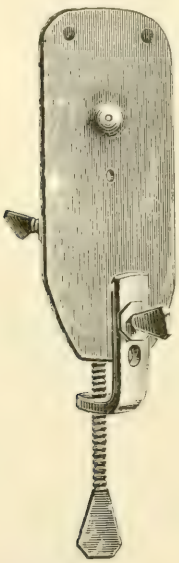
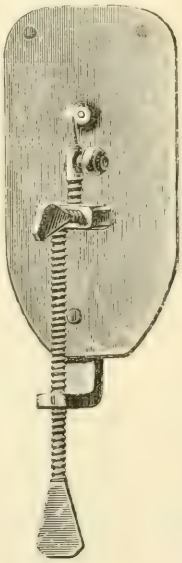


Fig. 216.



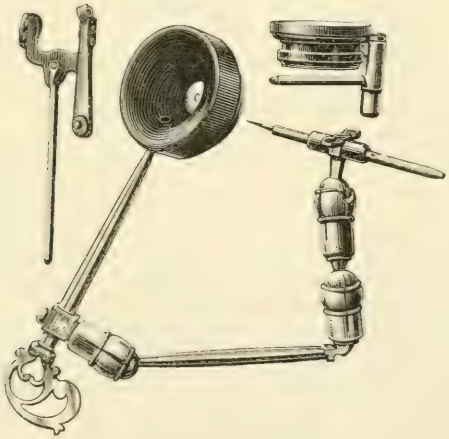
rivets, two at the upper end, and one at the lower. The object is held in front of the lens on the point of a short rod, the other end of which screws into a small block or stage of brass, which is riveted somewhat loosely on the smoothed cylindrical end of a long coarse-threaded screw, acting through a socket angle-piece attached behind the lower end of the plates by a small thumb-screw. The long screw serves to adjust the object in the axis of the lens in the vertical direction, whilst the pivoting of the socket angle-piece on its thumb-screw gives lateral motion. The object-carrier can be turned on its axis, as required, by screwing the rod into the stage. For focusing, a

thumb-screw passes through the stage near one end, and presses vertically against the plates, causing the stage to tilt up at that end; the fitting of the long screw carrier (angle-piece) is such that the stage at the end is sprung down somewhat forcibly on the brass plates, and it is against this pressure that the focusing screw acts. The metal knob on the object-carrier has a small projection, which appears to have been intended by Leeuwenhoek to fit in the hole in the brass plates beneath it, and thus retain the object opposite the lens.

It is evident from the extreme simplicity of the construction of this Microscope that the success of Leeuwenhoek's investigations did not depend essentially on the excellence of the instruments he employed, and as has been before remarked, it is simply wonderful that he was able to do such work with them as is recorded in his publications.

Musschenbroek's Microscope.—Prof. Hübrecht also brought with him the Musschenbroek Microscope shown in fig. 217 (about 2/3 size), which is only second in interest to that of Leeuwenhoek. It was

Fig. 217.



devised by J. van Musschenbroek (about 1695), the brother of P. van Musschenbroek, who became Professor of Mathematics and Physics at the University of Utrecht. The first representation of this form of instrument was given by Zahn, in his 'Oculus Artificialis,' 2nd ed., 1702, p. 781.

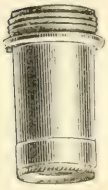
The object-lens is a simple bi-convex lens, mounted between two plates of brass, having minute central apertures forming diaphragms fitting in a horn cell, pierced laterally so as to be adjustable on the end of a metal rod-support, which is connected, by a second rod and three ball-and-socket joints, with a slide-socket in which various object-carriers are placed. The objects were held on the end of a

pin, shown in the fig. There is also a small wooden stage on which materials, &c., can be placed, or a bottle or test-tube can be stood upon it and held in place by being tied to a rod which slides vertically in the brass socket supporting the stage. The carrier on the left is provided with a long spring, under which rods of various shapes for holding objects can be slid and rotated in notches and holes made on either side of the fork-support.

This is the first application known to us of ball-and-socket movements to a simple Microscope.

Beeldsnyder's Achromatic Objective.—Another object of interest brought by Prof. Hübrecht, was the objective shown in fig. 218, which is of special interest in the history of the evolution of the Microscope from the fact that the late Prof. P. Harting * assigned its construction to about the year 1791, by François Beeldsnyder, of Amsterdam.

FIG. 218.



The combination consists of two bi-convex (green) crown lenses of 22 mm. and 19 mm. focus respectively, with an interposed bi-concave flint lens, the combined focus being 21 mm., and the diameters 6·5 mm. The lenses fit somewhat loosely in a brass cell screwing into the brass mount. The surfaces are somewhat imperfectly polished. The image obtained by the objective when used with an eye-piece, is but little better than that given by an ordinary non-achromatic simple object-lens diaphragmed as was usual before the application of achromatism. The increase of light due to the greater aperture hardly compensates for the loss due to the greyness of the polish.

Queen's "Parfocal Eye-pieces."—Messrs. J. W. Queen and Co. announce † that they are prepared to furnish eye-pieces (parfocal = of equal focus) which can be "changed without altering focus," or, in other words, eye-pieces with which the amplification of the Microscope is in exact inverse proportion to their focal length. This is accomplished by so adjusting the mounting of the eye-pieces that their anterior principal focus always lies at the same place in the body-tube.

The position of the anterior principal focus is readily calculated for every eye-piece. If a is the distance of the diaphragm from the field lens, and x the focal length of the latter, the distance of the anterior focus above the diaphragm will be

$$\underbrace{\beta = \frac{a^2}{x-a}}_{\text{strictly}} = \underbrace{\frac{a^2}{x}\left(1+\frac{a}{x}\right)}_{\text{approximately}}.$$

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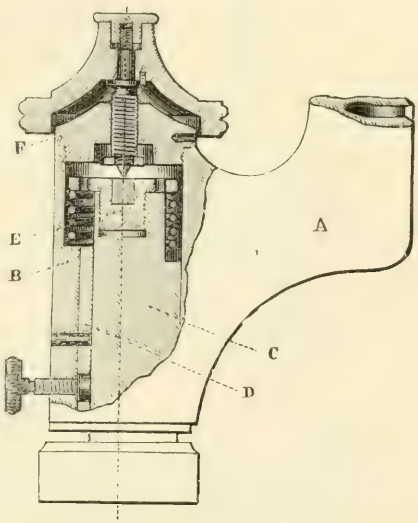
* 'Das Mikroskop' (German trans.), 2nd ed., 1866, iii. pp. 132–3.

† Micr. Bulletin (Queen's), iii. (1886) p. 31.

Fine-Adjustment to the New Zeiss Stands.* — Dr. S. Czapski gives a short account of the simplified construction of the fine-adjustment as now adopted for the Zeiss Microscopes.

The triangular bar C, fig. 219, is screwed firmly to the stage. On it moves a hollow piece B, which is connected inseparably with the arm A carrying the tube. The accuracy of the fitting of B and C is insured by the brass plate D, which is fastened to B by a pin. At its upper end C is cut away for about 15 mm. and B hollowed out at the corresponding place so that space is obtained for a spiral spring. This spring bears below against the hollowed out part of B, its upper end being connected with the projections of a piece E, screwed into C. The piece B is closed above by the brass cap F, in which is the female screw. To the top of the micrometer screw is fitted a bell-shaped head, and at its lower end is a small nut for preventing inadvertent extraction of the screw. The lower end of the screw is rounded off and bears against the flat surface of a hard steel cylinder let into E. The space allowed for the play of the screw is only 5 mm., but this is sufficient for all practical purposes.

Fig. 219.



Notwithstanding the relatively long female screw (which guarantees safety of movement and slight wear and tear), the fine-adjustment screw is on the whole rather short and correspondingly firm. The binding screw at the back of B serves to fix B in any desired position (during transport, &c.), and thus to prevent the screw mechanism from injury.

How the apparatus works is evident from the fig. When turned the micrometer screw remains in the same place, bearing against C. The female screw on the other hand moves over it, raising or lowering the tube-carrier B A connected with it. By its own weight A B counteracts the rise, and thus supplies the place of the strong spiral spring formerly employed. The weak spring here adopted acts in the same direction as the weight of A B, and serves to assist the latter when the upper part of the Microscope is placed horizontally. The micrometer screw is a left-handed one, in order that when the screw head is turned to the right the tube, as is usual, may sink.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 207–9 (1 fig.).

Wenham's Frictionless Fine-Adjustment.—Messrs. Ross have applied to Mr. F. H. Wenham's Radial Microscope the form of fine-adjustment shown in fig. 220.

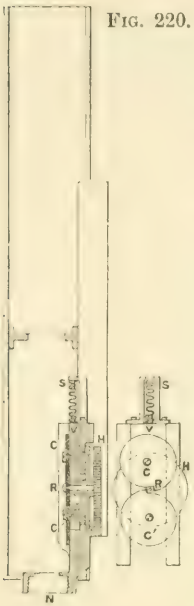


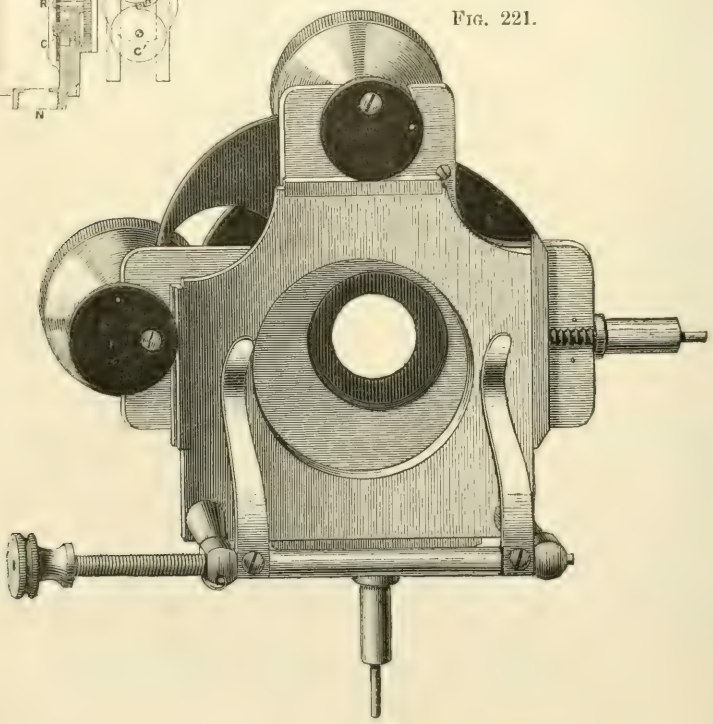
Fig. 220.

A V-slide is fitted within the body-tube, carrying at its lower end the nose-piece N, and is pressed downwards by a spiral spring S. It is moved against the spring by the revolution of two "snail" cams C C', between the edges of which revolves a steel roller R forming the axis of, and actuated by a large milled head H, passing longitudinally through the slide of the coarse adjustment and projecting slightly on either side, in a convenient position for work.

By this system an extremely sensitive focusing is obtained, though a difficulty has to be overcome in the tendency of the roller to slip between the cams.

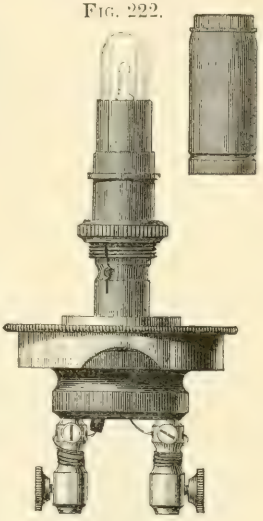
Swift's Cam Mechanical Stage.—Mr. J. Swift, in 1884, utilized the cam for a mechanical stage in the manner shown in fig. 221. There

Fig. 221.



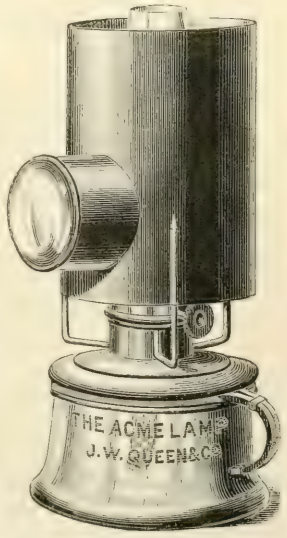
are two cams, one on the left and the other in front, and they are actuated by large milled heads beneath the stage. Two spiral springs on the projecting rods press the stage plates against the cams. A very smooth motion is thus obtained. The spring clips are raised by the milled head on the left against the action of a spiral spring which is wound on the axis, and they provide an unusual depth of space for cells or other thick objects. The stage was more especially intended for use with a photo-micrographic camera.

Fig. 222.



Electric Incandescence Lamp.—This, fig. 222 (received anonymously from America), is a very convenient form of incandescence lamp for use in the sub-stage. The glass receiver with the carbon filament and the wires for connecting with the battery are screwed into the sub-stage adapter shown in the fig., from which they are, however, insulated by ebonite. Over the glass receiver fits a piece of tubing (shown at the side), which carries either a condensing lens, a disc of blue glass, or a pin-hole diaphragm. A milled ring working in a screw-thread, tightens or loosens the setting of the lamp, so as to allow of its renewal in case of breakage.

Fig. 223.



Queen's Acme Lamp.*—Mr. J. W. Queen in designing this lamp (fig. 223), has followed out his belief that a Microscope lamp attaining the highest efficiency could be produced at a low cost.

The careful and exact application of a finely figured, ground, and polished bull's-eye lens permits the use of a very small flame and wick. This feature will, it is anticipated, prove a valuable one for summer work, where the heat of most lamps is very objectionable. The bull's-eye gives sufficient light for a 1/12 in. objective, using only the usual substage condenser when the lamp is at the distance of 3 feet from the mirror.

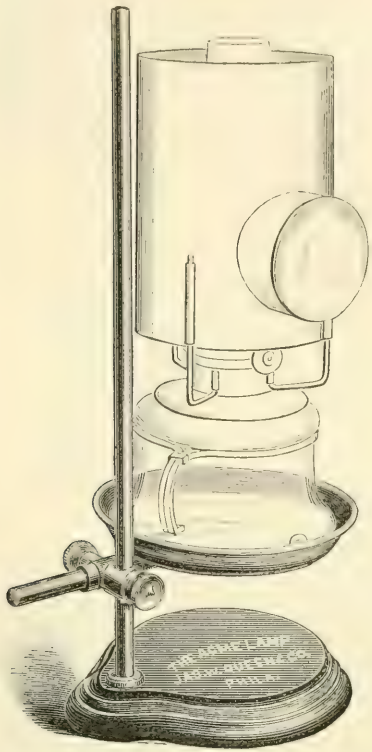
The lens can be set higher or lower, the flame placed flat or edgewise towards the lens. The shade is japanned outside, but bright inside, in order that it may become but little heated by

* Micr. Bulletin (Queen's), iii. (1886) p 27 (1 fig.).

absorption from the radiation of the flame. The handle, being of brass, obviates the danger from breakage incident to glass handles.

If a larger flame is desired, a larger burner and chimney may be readily applied. The adjustable stand (fig. 224), since issued,* enables the lamp to be set and clamped at any height. The lamp may also be inclined by means of the horizontal axis, so as to throw the beam of light downward or upward, as may be necessary, and there clamped.

Fig. 224.



Thompson's Modification of the Nicol Prism, giving wider angle of field.†—In the ordinary Nicol prism the available polarized field is limited, on the one side by the intrusion of the ordinary ray, and on the other by the vanishing of the extraordinary ray by total reflection. Of the various methods suggested from time to time for widening the available angular aperture, some have affected one side of the field, some the other, some both. For example, the suggestion made by Prof. S. P. Thompson in 1881 (and by Mr. Glazebrook in 1882) to alter the prism in such a way as to make the balsam-film a principal plane of section, has the effect (irrespective of the external shape of the prism, which we may suppose given) of throwing back to its furthest possible limit (for any given cement) the point at which the extraordinary ray vanishes by total reflection. The obliquity of the end-face, other things being given, affects the limit of intrusion of the ordinary ray to a much greater degree than it affects the extraordinary ray, hence by increasing the slope of the end-faces we may add to the available width of field, but this involves increased distortion of the field as well as loss of light. The use of a more highly refringent cement than Canada balsam causes a gain on the side of the extraordinary ray—it thrusts the blue iris further back—but

* Micr. Bulletin (Queen's), iii. (1886) p. 35 (1 fig.).
† Phil. Mag., 1886, pp. 478–80 (1 pl.).

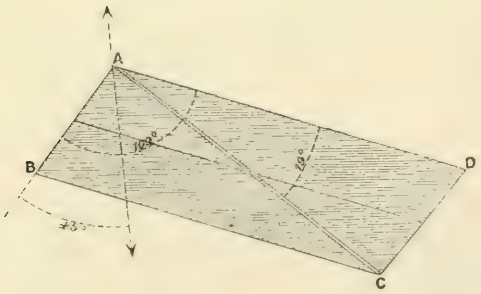
causes a slight loss on the side of the ordinary ray, which intrudes a little more than before.

Now, taking the Nicol prism as it is ordinarily made, there would be a real gain, if it could, without additional labour or cost, be so cut as either to widen the field (using the same length of prism as before) or to shorten the length of the prism (if obtaining the same angular aperture as before). The method of cutting adopted by Hartnack, and that suggested in 1881 by Prof. Thompson, both add to the cost of spar and to the labour of cutting. In Hartnack's construction the width of field is gained partly by employing linseed oil, partly by the device of making the plane of the film lie at right angles to the crystallographic axis of the spar. In Prof. Thompson's construction of 1881 the balsam-film was made to lie in a principal plane of section, whilst the principal axis of vision through the prism was made to lie at right angles to the crystallographic axis. A gain of about 9° in the width of the field over that of a Nicol of the same external form was the result; being a little less for flattened prisms, a little more for oblique-ended prisms.

Prof. Thompson has now devised a simple modification of the mode of cutting the Nicol prism, which possesses several of the advantages of these costlier methods of construction, but without adding appreciably to the cost.

Fig. 225 shows the ordinary Nicol prism as usually cut, the end-faces A B and C D being natural faces of the crystal polished up. The books assert that makers of Nicol prisms cut down these faces, making them still more oblique by 3°, but the author has not found any constructor who does this. The natural angle between the face A B and the arrête A D is about 109°. The crystallographic axis

Fig. 225.

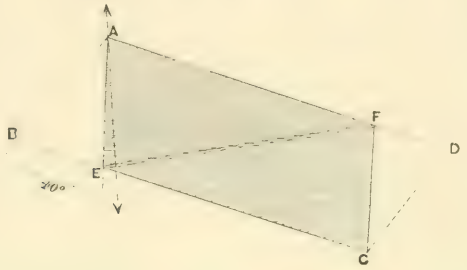


makes about 45° with the end-face A B. The balsam-section is at about 90° to the plane of the end-face. The consequence of this is that there are about 45° between the plane of the balsam-film and the crystallographic axis. This limits the field: those rays which traverse the prism at small angles to the film, and which would traverse the film if the crystallographic axis were at right angles to it (as in the

Hartnack prism) are totally reflected out, because the crystallographic axis slopes at 45°.

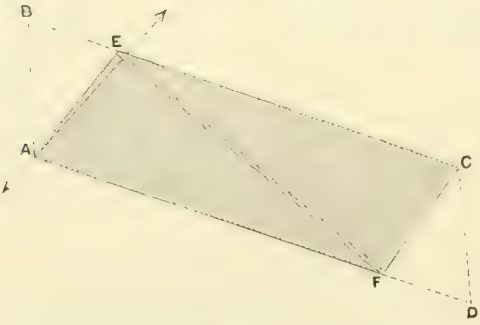
To remedy this the crystal is cut in the manner shown in fig. 226 or fig. 227. Fig. 226 represents a piece of spar of the same size as fig. 225. The end-faces are first cut away about 40° each, making the ends of the prism A E and F C reversed in position, but inclined at

Fig. 226.



about 69° instead of 71° to the long edges. The prism is then cut across E F, which makes about 89° with the end-faces. The result is a shortened and "reversed" nicol, in which the crystallographic

Fig. 227.



axis lies very nearly in the plane of the end-face, and in which the balsam-film is very nearly at right angles to the crystallographic axis. Or, comparing the two,—

	Ordinary Nicol. °	Reversed shortened Nicol. °
Obliquity of end-face	71	69
Angle between end-face and crystallographic axis	45	5
Angle between balsam-film and crystallographic axis	45	94

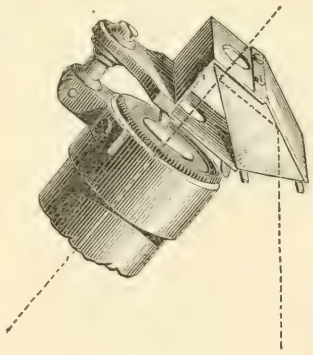
The result is that the blue-iris limit is thrown right back, and a shorter prism is obtained, having an equally wide field or wider.

Fig. 227 shows the same method applied to a slightly longer piece of spar, producing a "reversed" prism of precisely the same external form as the ordinary nicol, and having indeed everything the same, save the direction of the crystallographic axis, as a comparison of figs. 225 and 227 will show.

The method of "reversing" the section is of course equally applicable to flat-ended nicols. If a piece of spar is first cut so that the terminators are orthogonal to the long edges of the prism, it is obviously just as easy to slice the prism with a section that is very nearly perpendicular to the crystallographic axis as to slice it with one that makes only 45° with it.

This new method of construction may be regarded as a compromise, for the sake of cheapness, between the method of Hartnack and the older method of Nicol.

Fig. 228.

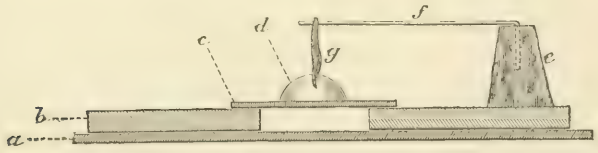


Nachet's Camera Lucida.—This is now made by M. A. Nachet for use with an inclining Microscope, when it takes the form of fig. 228. The difference between this and the camera for a vertical Microscope is principally that the surfaces of the prism have been cut to the angles necessary to produce an exact coalescence of the images when the body-tube is inclined 45°.

Instead of the small central prism of the older forms, M. Nachet uses with all his cameras the thin coating of gold suggested by Prof. G. Govi, the reflecting power of which is sufficient to give a clear image of the pencil, while its translucidity allows the object to be seen at the same time.

Apparatus for cultivating Plasmodia.*—In his observations on an aquatic *Myxomycete*, Mr. H. Marshall Ward found that the plasmodia

Fig. 229.



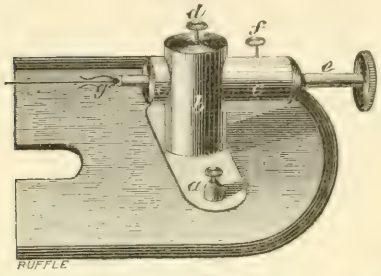
tended to the upper parts of the culture drop, and he therefore used the apparatus shown in fig. 229, in which the drop *d*, containing

* Stud. Biol. Laborat. Owens College, i. (1886) pp. 64–85 (2 pls.).

myxamœbæ and plasmodia, is inverted, instead of hanging down from the under side of the cover-glass *c* into the cavity of the bibulous paper cell *b* (fixed to the slide *a*). A piece of hyacinth root *g* passes into the drop, being suspended by a glass filament *f* supported by a cork *e*. The whole is placed in a larger damp chamber, and the root kept thoroughly wet.

Apparatus for the microscopic detection of Rhombic Pyroxene.*—Dr. R. Küch uses the contrivance shown in fig. 230 to determine hypersthene where this mineral is present in a rock with a larger proportion of monoclinic augite.

Fig. 230.



The cylindrical brass pillar *b* (2–3 cm. in height) is fixed on a brass plate *a*, 1 cm. broad and 1 mm. thick; a hole is bored at the upper end, and through this passes a hollow cylinder which can be rotated, but cannot be shifted to right or left on account of the collars *c c*. The screw *d* serves to fix the cylinder to *b*; through the cylinder passes the rod *e*, which can be moved to right or left and is fixed by the screw *f*. This rod terminates at one end in the clamp *g*. The apparatus is fixed on the stage by two screws, so that the prolongation of *e* passes through the axis of the Microscope.

To use the apparatus the pyroxenic constituent is isolated and fixed with Canada balsam between two cover-glasses, which are then placed in the clamp *g*; by moving *e* and the slide itself one crystal after another is so placed that its crystallographic vertical axis coincides with the axis of *e*; *f* is then clamped, and each crystal may then be turned about its vertical axis and the extinction tested in different positions, care being taken to clamp the screw *d* when the stage is rotated.

Sahli's Automatic Regulator for an Incubator heated by Petroleum.†—Dr. H. Sahli's apparatus, the general appearance of which is shown in fig. 231, consists of an iron vessel A B C (fig. 232) divided into (1) a hot-air chamber A C, (2) the incubator proper, and (3) a space filled with water surrounding the latter. From the air-chamber descends a pipe D, into the lower extremity of which the chimney of the lamp fits. On one side is a shaft K, to which at its junction with D is attached a valve H J moving on a hinge at H. H G is a lever raised by the needle W.

The lamp is provided with two chimneys; the smaller used for incubations, the larger for sterilizing. The regulator apparatus

* Neues Jahrb. f. Mineral., Geol. u. Palæont., i. (1886) pp. 35–48 (2 figs.).
† Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 165–73 (3 figs.).

consists of a broad glass tube M, into which is blown a thin tube L. M L, placed in the water-tank, communicates through a hole in the lid with the caoutchouc tube P L. The lower part of this glass

FIG. 231

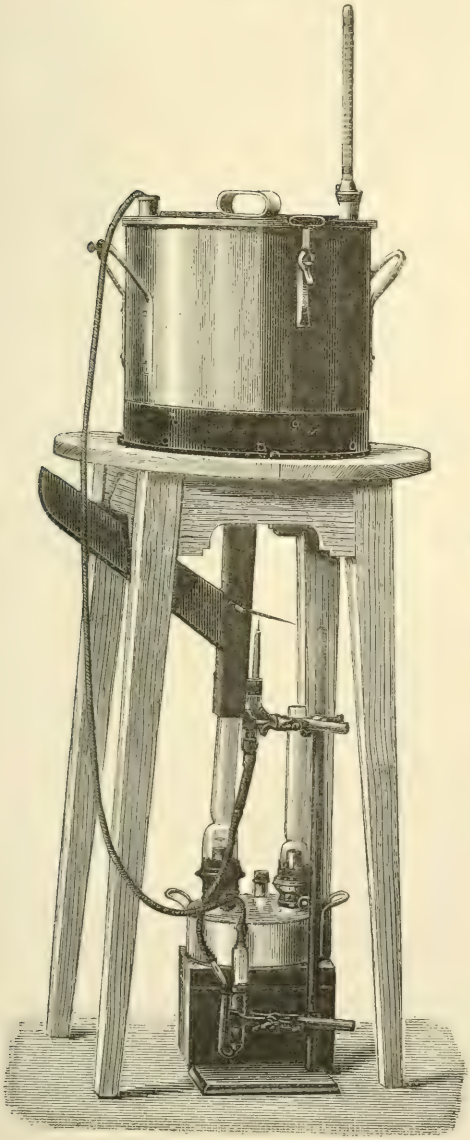
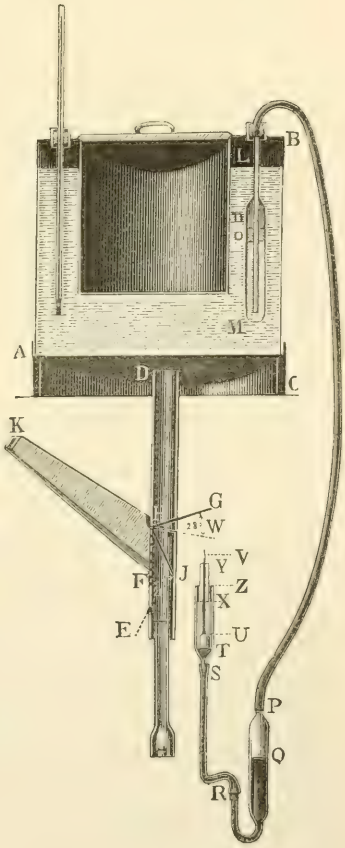


FIG. 232.



vessel, as well as its tubes as far as P, is filled with water, while above it is a layer *n o* of ether for temperatures about 40° C., or of petroleum-ether for temperatures of 56°. P R is another glass vessel, with an ascending limb, which contains mercury, and is connected by means of a rubber tube with the cylinder Z S. Herein is a float T, from which proceeds the wooden rod V U, terminated by the needle W. The rod passes through a tube X Y inserted in a cork which closes the end of the cylinder at Z. The tube X Y in addition to acting as a guide-bearing for the rod V U, has also the further object of preventing, in case the pressure of the ether should rise too high, the overflow of the mercury or the bursting of the vessel. The upper end of the float T U is so shaped that if it is pressed against the tube X Y, the latter does not close but permits the mercury to ascend the tube, after flowing over the float. If the tube is only a few centimetres high an overflow of the mercury is hardly conceivable, for such an ascent would correspond to a temperature difference of some degrees Celsius in the incubator, and this, in consequence of the regulator, never happens. The two glass tubes P R and S Z are clipped to an iron burette-holder (fig. 231).

The action of the apparatus is sufficiently simple. As the water in the iron vessel gets hot, the ether expands and drives the water in the glass bulb from M to C onwards, so that the mercury rises up the tube R S and so presses on the float T, which in its turn raises the needle W. The needle, as already mentioned, presses against the lever, which if in the position W before, now rises to G, and by this means moves the valve H J from F to J, thereby cutting off the ascent of the hot air, all of which now passes out through K. As the temperature falls, so do the needle and the lever, the valves consequently returning towards F.

The temperature depends partly on the boiling point of the fluid *n o*, and partly on the difference between the levels of O and T. The higher P R is placed the sooner the mercury reaches the float, and the sooner therefore the heating process is interrupted. A bulbed pipette is described which is used for filling M, N.

Tursini's Photomicrographic Apparatus.*—In place of the small dark chamber of the ordinary apparatus for photomicrography, Signor Tursini proposes a camera obscura which is large enough to receive the operator as well as the necessary instruments and reagents. The Microscope and the preparation to be photographed are outside the chamber, the image is projected into the interior. Near the Microscope is an oblique aperture through which the operator, without leaving the chamber, can regulate the position of the mirror, the preparation, the fine-adjustment, &c. In this way the operations are better watched, and therefore the results are better.

Phototypic Process applicable to the Reproduction of Photomicrographs.†—This method, which is the invention of M. A. Denaeyer, depends on the insolubility of bichromate-gelatin produced by the

* Il Morgagni, 1886, p. 90.
† Bull. Soc. Belge Micr., xii. (1886) pp. 92-6.

action of the luminous rays proportional to the "photovaleur" of the different whites of the image it traverses. The preparation of the glass plates requires the successive employment of the following products:—

Mixture A. Whites of two eggs beaten to a froth; solution of silicate of soda, 60 parts; distilled water, 120 parts. This solution having been introduced into a florentine flask is allowed to stand for twelve hours. It is the lower limpid layer which is poured on the glass plates.

Mixture B. Very hard white gelatin, 20 parts; distilled water, 200 parts. To this solution, made in a water-bath at a temperature of 45°–50° C., is added bichromate of ammonia 4 parts, dissolved in distilled water, 40 parts; ammonia, 15 drops. The mixture is filtered at a temperature of about 45° through white filter paper.

In order to obtain a uniform layer, the glass is placed on three wooden cylinders, provided with adjusting screws; and then some of the mixture having been poured on, the glass slide is gently tilted with the hand, and then a white thread rendered tense by being stretched from the points of an iron arc, serves to carry along the viscid fluid without loss of continuity and production of bubbles. The glass is next dried in the air, and afterwards washed in cold water for five minutes. It is next placed in a heating apparatus and carefully levelled in the horizontal position. Here it is left for two hours at a temperature of 57° C., and while still warm it is coated with a layer of mixture B, the same procedure being adopted as for mixture A. The glass is then again transferred to the heating stove, where it is allowed to dry thoroughly at a temperature of 57° C. (about two hours).

When dry, the glass is sensitive to luminous rays. After cooling it is placed in the press-frame above and in contact with the negative, care being taken to cover all parts of the glass which are not to receive the luminous action with black paper. Exposure is then made to diffuse light. The duration of the exposure varies from one hour to five minutes, according to the greater or less intensity of the negative. The image is shown in relief on the layer of bichromated gelatin.

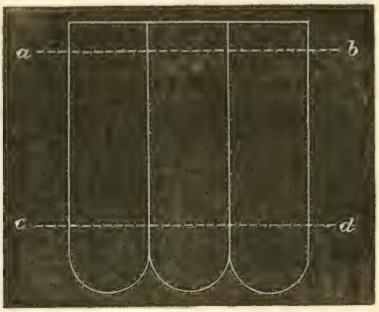
Before proceeding to print, the glass must be well washed to remove any excess of bichromate, or better, it may be left for five or six hours in running water. It is next dried in a dark place. To obtain the positive the glass is moistened with the following mixture: Glycerin, 100 parts; ammonia, 5 parts; hyposulphite of soda, $2\frac{1}{2}$ parts. After ten minutes the excess of the "Moistener" is removed, first with a sponge, and next with a piece of clean linen; the latter must be dabbed, and not rubbed on.

The plate is to be inked with two special phototypic inks, laid on with rollers. It is necessary to remoisten with the glycerin mixture after every dozen copies. From four to eight hundred copies may be obtained from one plate.

It is not necessary to perform the operations in an absolutely dark room; it is almost sufficient to draw down the blinds.

Cylinders which act as Lenses, and give an Optical Image.*—Prof. S. Exner having previously found,† in examining the eye of *Hydrophilus piceus* with his micro-refractometer, that each facet of the cornea is a cylinder of continually increasing refractive power from the circumference to the axis, has been led to study the optical action of such a cylinder. That the images produced by the facets are not only due to their spherical terminations was shown by removing the

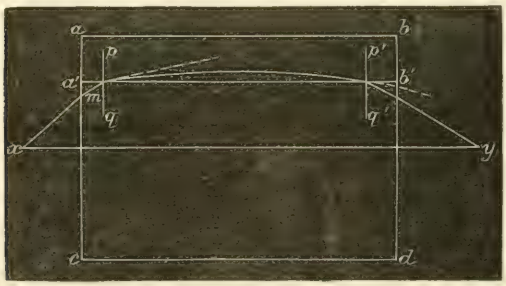
Fig. 233.



latter, when an inverted image was produced by the section between *a b*, *c d* (fig. 233), and this must be due to the fact that each cylinder acts as a lens by reason of its varying optical density. The subject is mathematically treated by Prof. Karl Exner, but the general results are suggested by the following simple considerations:—

Let *x y* (fig. 234) be the axis of the cylinder of which *a c*, *b d*, are

Fig. 234.



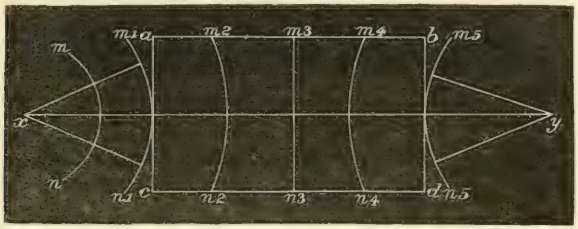
the plane terminations perpendicular to *x y*, and suppose the refractive index to be a maximum along the axis, and to diminish regularly towards the circumference. Then the course of a ray *x m* incident at *m* is shown by the curved line *x m y*, since the ray on encountering successive strata of varying density will be continually refracted

* Pflüger's Arch. f. d. gesammt. Physiol., xxxviii. (1886) pp. 274–90 (10 figs.).

† See this Journal, *ante*, p. 328.

towards the axis, and is at one part of its path parallel to the axis. Consider next a spherical wave $m\,n$ (fig. 235) proceeding from x; after entering the cylinder, as at $m_1\,n_1$, it will be gradually altered in shape,

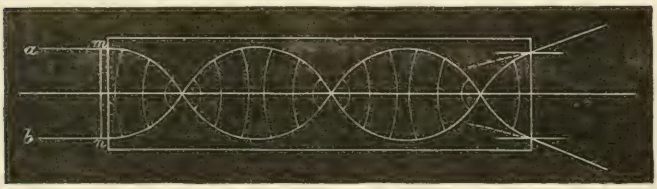
Fig. 235.



as shown by $m_2\,n_2$, $m_3\,n_3$, $m_4\,n_4$, successively (the velocity being least along the axis), and will emerge as a concave wave at $m_5\,n_5$, so that rays diverging from x will converge to y. The figure also indicates that if the cylinder be cut through at $m_3\,n_3$, where the wave-front is plane, the beam will emerge parallel to the axis; in other words, x is the focus of the cylinder $a\,c\,m_3\,n_3$, and y is the focus of the cylinder $b\,d\,n_3\,m_3$. The form of the curve $m_5\,n_5$ will depend upon the law by which the index varies, but in any case it will be a surface of revolution about the axis, and consequently the portion in close proximity to the axis may be replaced by its sphere of curvature; hence, if central pencils only be taken into account, it is clear that an image of x will be produced at y.

It may be proved that the focal length is inversely proportional to the length of the cylinder; this, however, is only true within certain limits, since with a long cylinder the course of a beam of parallel rays $a\,b$ may be periodically re-entrant, as shown in fig. 236,

Fig. 236.



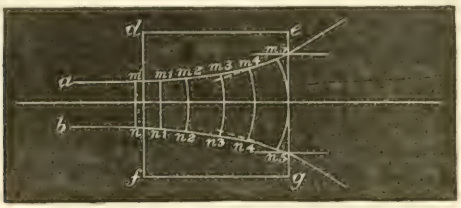
and there will be a succession of foci within the cylinder; the latter should therefore be shorter than the distance between two consecutive foci.

It may be shown also that the ordinary lens formula $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ is equally true for the cylinder, u and v being the distances of the object and image respectively, and f the focal length. Such a

cylinder behaves, therefore, like a convex lens, and can be treated in a similar way as regards the calculation of the sizes and positions of images, &c. Precisely similar considerations will show that a cylinder in which the index *increases* from the axis towards the circumference will behave as a concave lens (fig. 237).

It might be supposed that if at any point a ray is travelling

Fig. 237.



parallel to the axis it will continue to do so, since it is travelling along strata of constant index; but if we consider the elementary waves which constitute the ray, it will be seen that those which are nearer the axis are propagated with diminished velocity, so that the ray as a whole will have a curved path.

Two points of interest proved in the mathematical investigation are: (1) Whatever be the law according to which the index varies, in the immediate neighbourhood of the axis it will be a parabolic law; in other words, if from all points of the base lines be drawn parallel to the axis and proportional to the index of refraction at those points, their extremities will form a surface of revolution which is in all cases a paraboloid near the axis. (2) If all the rays diverging from a point in the axis are to converge to a point after refraction through the cylinder, the law of the index must be a parabolic law.

To put the theory to the test of experiment, Professor Exner, following the example of Matthiessen, prepared cylinders of varying optical density from celloidin and gelatin. The celloidin was for this purpose cut from a plate with a cork-borer into cylinders 5–10 mm. in length and breadth, placed between glass plates to protect the ends, and then immersed for some hours or days in a mixture of alcohol and ether. Gelatin cylinders were prepared by filling a glass tube with a gelatin solution, treated with salicylic or carbolic acid; this is allowed to harden, and then extracted by warming the tube for a few seconds. A cylinder cut from such a column is then fixed between glass plates, and immersed for a day in water. Cylinders of celloidin and gelatin treated in this way are found to act as lenses in accordance with the theory. Thus Exner was able to manufacture some of two inches focal length, which gave fairly good images, and could be used as rough magnifying lenses, enabling him to verify approximately the formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$. Cylinders which act as concave lenses may be made by exposing the rod of gelatin to the air for

some days or weeks after it has been taken out of the glass tube, and by combining a convergent and a dispersive cylinder it was possible to construct a small Galilean telescope.

The path of rays through cylinders formed by coaxial shells of varying index is also investigated by Dr. L. Matthiessen, with special reference to the eyes of different insects,* who agrees with Professor Exner that the spherical ends of the facet cylinders have very little to do with their action as lenses, which is to be attributed solely to the variation in optical density. He is, however, of opinion that the cylindrical lenses of the cornea are not composed of coaxial cylinders, but of successive shells, like the chambers of *Orthoceratites*, the refractive index diminishing from one to another in the direction of their convexity.

In a subsequent note † Professor Exner says that the cylinders of varying density which were at first made of gelatin have now been constructed of glass at the Jena Glastechnisches Laboratorium. At present their optical density can only be made to diminish from the circumference towards the axis. They act as dispersive lenses, and give clear images when they are free from cavities. The only marked defect is the double refraction which duplicates the image near the borders of the field of view, and indicates that the variation of density is not quite regular along the radii of the cylinder.

Definition of Hairs, "Test Rings."‡ — In articles on "Microscopical Advances, Ancient and Modern," Dr. G. W. Royston-Pigott says that, he considers the "advances of the accuracy and power of the Microscope is well shown in the well-developed structure of hairs. A favourite object figured in antiquated books is the hair of the Indian bat. Quekett represents it as frilled with a kind of coronet of small hairs, ringed at regular intervals, leaving the intermediate transparent quill exposed." With an "oil-immersion 1/12th, and a large angle in the oil condenser, instead of frilled hairs, which are purely imaginary, a beautifully *serrated cup*, with concave notches, is seen, and edges as black as jet, ornamenting the whole of the stem at equal intervals. After so many years of observation of this object, this result is perfectly startling, and throws a strong doubt upon innumerable accepted appearances. The black boundary edges are very nearly 100,000th thick."

As to "test rings" he says that "when a brilliant white disc in diatoms can be detected, it is generally accompanied by a jet black marginal ring all round the spherule; and in brilliant spherules 1/40,000 in. in diameter, this black ring has been frequently estimated at 1/6th of the disc, or 1/240,000 in. thick. This ring plays so important a part in the definition of diatoms, cells, and molecules, that I shall ask leave to call it the *spherule test ring*, or, shortly, the *test ring*; for, if a glass giving 800 diameters will not show it in a minute spherule (1/90,000th), it cannot be rated as of the finest quality."

* Exner's Repert. d. Physik, xxii. (1886) pp. 333–53 (10 figs.).
† Arch. f. d. gesammt. Physiol. (Pflüger), xxxix. (1886) pp. 244–5.
‡ Eng. Mech., xlii. (1885) pp. 331–2 (14 figs.).

ALLMAN, G. J.—**Obituary of G. Busk, Hon. F.R.M.S.**
Nature, XXXIV. (1886) pp. 387–9.

American Society of Microscopists.—Ninth Annual Meeting.
Amer. Mon. Micr. Journ., VII. (1886) pp. 161–3.
The Microscope, VI. (1886) pp. 200–1, 202, 202–6 (Abstract of President's Address), 212.

Bausch and Lomb Optical Co.'s New Student Microscope. [*Supra*, p. 1037.]
The Microscope, VI. (1886) p. 199 (1 fig.).

BECK, J. D.—**[Working Distance of High-power Objectives.]**
[" I am no expert in optics, but I do firmly believe that the form, the construction, the arrangement and combination of lenses for objectives can be modified so as to give a working distance between the objective lens and cover-glass of 1/4 in. for a 1/6 in. objective, and 1/32 in. for 1/50 in. objective. I may be looked on with apparently good reason as a crank for entering the field so boldly with such an idea. Things have been accomplished (successfully) apparently as difficult as this enthusiastic idea of mine. For example, high angles of aperture of objectives. It appears that 90° was at one time considered the highest limit of angle of aperture for objectives, and the man who predicted it possible to construct an objective with an angle of 180° aperture certainly would have been called a crank, but it has been successfully accomplished 'just the same.' *How much higher the angle can be applied to objectives I do not know. It may be the limit.* Is it not possible or even probable that the working distance may be increased to the limit mentioned?" ! (Italics ours.)]
The Microscope, VI. (1886) p. 215.

BEHRENS, W. J.—See Unna, P. G.

BOSTWICK, A. E.—**On a Means of Determining the Limits of Distinct Vision.**
[*Post.*] *Science*, VIII. (1886) p. 232 (1 fig.).

CZAPSKI, S.—**Mitteilungen über das glastechnische Laboratorium in Jena und die von ihm hergestellten neuen optischen Gläser.** (On the Jena Glass Laboratory and the new kinds of optical glass made there.)
[Cf. this Journal, *ante*, pp. 316 and 849.]
Zeitschr. f. Instrumentenk., VI. (1886) pp. 293–9 (in part).

DELAGE, Y.—**Compresseur nouveau, à pressure régulière et à retournement.** (New Compressor with regular pressure and reversible.)
[*Ante*, p. 862.] *Arch. Zool. Expér. et Gén.*, IV. (1886) xix.–xxi. (2 figs.).

EXNER, S.—**Nachtrag zu der Abhandlung "Ueber Cylinder, welche optische Bilder entwerfen.** (Supplement to the article "On Cylinders which form optical images.") [*Supra*, p. 1062.]
Arch. f. d. gesammt. Physiol., XXXIX. (1886) pp. 244–5.

FRANCOTTE, P. — **Descriptions des Objectifs construits avec les verres nouveaux.** (Description of the Objectives constructed of the new kinds of glass.)
[Cf. *ante*, pp. 316 and 849.] *Bull. Soc. Belge Micr.*, XII. (1886) pp. 100–8.
Journ. de Microgr., X. (1886) pp. 467–70.

GÄNGE, C.—**Lehrbuch der Angewandten Optik** in der Chemie, Spectralanalyse, Mikroskopie, Polarisation. Praktische Anleitung zu wissenschaftlichen und technischen Untersuchungen mit Hülfe optischer Instrumente nebst theoretischer Erklärung der beobachteten Erscheinungen. (Compendium of Optics as applied in Chemistry, Spectral Analysis, Microscopy, Polarisation. Practical instruction in scientific and technical investigations with the aid of Optical Instruments and theoretical explanations of the phenomena observed.)
['The Microscope,' pp. 58–60 (2 figs.), 67–84 (7 figs.), 106–8, 173–82, 197–8, &c.]
xi. and 463 pp., 24 pls., and 162 figs., 8vo., Braunschweig, 1886.

Glass, the new Optical.
[Cf. *ante*, pp. 316 and 849.] *Nature*, XXXIV. (1886) pp. 622–3.
See also *Engl. Mech.*, XLIV. (1886) p. 286.

H.—**The Benefits of Improvements in Objectives.**
[Review of the President's Address (R.M.S.) 1886. "No one can read Dr. Dallinger's contributions without a feeling of respect and admiration for those qualities of mind and industry that have enabled him to carry on such difficult observations so long and successfully."]
Amer. Mon. Micr. Journ., VII. (1886) pp. 172–3.

Haeckel, E.—[**Use of both Eyes with the Microscope.**]
["According to the same law of divergent adaptation, both eyes also frequently develop differently. If, for example, a naturalist accustoms himself always to use one eye for the Microscope (it is better to use the left), then that eye will acquire a power different from that of the other, and this division of labour is of great advantage. The one eye will become more short-sighted, and better suited for seeing things near at hand; the other eye becomes, on the contrary, more long-sighted, more acute for looking at an object in the distance. If, on the other hand, the naturalist alternately uses both eyes for the Microscope, he will not acquire the short-sightedness of the one eye and the compensatory degree of long-sight in the other, which is attained by a wide distribution of these different functions of sight between the two eyes. Here, then, again the function, that is the activity, of originally equally-formed organs can become divergent by habit; the function reacts again upon the form of the organ, and thus we find, after a long duration of such an influence, a change in the more delicate parts and the relative growth of the different organs, which in the end becomes apparent even in the coarser outlines."]
Amer. Mon. Micr. Journ., VII. (1886) p. 176.

Hénocque.—**L'Hématoscopie, méthode nouvelle d'analyse du sang, basée sur l'emploi du Spectroscope.** (Hæmatoscopy; a new method of blood analysis based on the employment of the Spectroscope.) [*Post.*]
Comptes Rendus, CIII. (1886) pp. 817–20 (3 figs.).

Hitchcock, R.—**Recent Improvements in Microscope Objectives.**
[Summarized statement of the modern theory of aperture.]
Amer. Mon. Micr. Journ., VII. (1886) pp. 190–3.

Jörgensen, A.—**Die Mikroorganismen der Gärungsindustrie.** (The microorganisms of the fermentation-trades [brewers, distillers, &c.].)
[Chap. i., pp. 1–24 (6 figs.) Microscopical and Physiological Investigation.]
viii. and 138 pp., 36 figs., 8vo, Berlin, 1886.

Lehmann, O.—**Ueber Mikroskope für physikalische und chemische Untersuchungen.** (On Microscopes for physical and chemical investigations.)
[*Post.*] *Zeitschr. f. Instrumentenk.*, VI. (1886) pp. 325–34 (4 figs.).

N., W. J.—**The Two Mirrors.** (*In part.*)
[On Illumination by Plane and Concave Mirrors.]
Sci.-Gossip, 1886, pp. 217–8, 248–51 (7 figs.).

Objectives, the New.
[Cf. *ante*, pp. 316 and 849.] *Science*, VIII. (1886) pp. 335–6.

Pelletan, J.—**Microscope spécial de MM. Bézu, Hausser et Cie. pour l'étude des Bactéries.** (Bézu, Hausser and Co.'s special Microscope for the study of bacteria.)
[Hartnack stand with circular rotating stage and glass plate. Abbe condenser. The objectives are the subject of the following Pelletanian puff. "Every one knows the reputation of the objectives of this house (!). We need not therefore eulogise them here, but we may add that the 1/12 homogeneous immersion of MM. Bézu and Hausser is absolutely of a superior quality. We have several times had occasion to compare it with similar objectives, German, English, or even American, and under all circumstances it showed itself superior by the delicacy and purity of the image, as well as by the absence of colour and distortion of the field. We do not hesitate, therefore, to recommend it in preference to all others."]
Journ. de Microgr., X. (1886) pp. 412–5 (1 fig.).

Pfeifer's (A.) Embryograph for use with Zeiss Microscopes. [*Post.*]
Stud. Biol. Laborat. Johns Hopkins Univ., III. (1886) pp. 480–1 (1 fig.).

Photography, advance of Pathological.
["In an editorial on the 'Advance of Pathological Photography,' the 'British Medical Journal' says that a perfect system of representing pathological specimens, as seen under the Microscope, by photography, is much to be desired, and it seems that such a system will very shortly be perfected."]
The Microscope, VI. (1886) pp. 201–2, from *Brit. Med. Journ.*

Power of a Microscope.
["The magnifying power of a Microscope centres in the lens," &c.!]
Scientif. Enquirer, I. (1886) pp. 190–1.

Proctor, R. A.—**Minute Writing.**
[As to minute writing of the Lord's Prayer. The 'Newcastle Weekly Chronicle' says that Mr. Proctor has sent three specimens of his skill in microscopic writing. "One of them is the Lord's Prayer written in less than a half-ring marked by a penholder smaller than an ordinary pencil-ring. Another is the same prayer occupying a space slightly over the half-ring. A few touches of the pen have given the latter specimen the appearance of the sun rising out of the sea. The third specimen is in some respects the most striking and curious of the three. It is the Lord's Prayer written three times over on three straight lines a shade over 2½ in. long. The writing in this case is so straight and minute that the three lines look to the naked eye like three ruled lines. And yet, when placed under a magnifying glass, every word is seen to be perfectly distinct."]
Knowledge, IX. (1886) p. 361.

Queen's (J. W.) Acme Lamp-stand. [*Supra*, p. 1054.]
Micr. Bulletin (*Queen's*), III. (1886) p. 35 (1 fig.).

Robin (C.), Sa Vie et son Œuvre. (Life and work of Prof. C. Robin, Hon F.R.M.S.) (*In part.*)
Journ. de l'Anat. et de la Physiol., XXII. (1886) pp. i.–xlviii. (portrait).

Royston-Pigott, G. W.—**Microscopical Advances. XIII., XIV.**
[Minute Coloured Imagery.—First Order of Interstitial Colouring. Second Order: Transmitted Colours. Solar Spectra emitted by small lenses. On the circular solar spectrum.]
Engl. Mech., XLIV. (1886) pp. 165–6 (2 figs.), 207–8.

Schröder, H.—**Ahrens' neues Polarisationsprisma.** (Ahrens' new polarizing prism.) [*Post.*]
Zeitschr. f. Instrumentenk., VI. (1886) pp. 310–1

Schultze, E. A.—**Five species of Triceratium.**
[Two artotype plates with 8 figs., from photo-micrographs with Wale's 1/12 in. and Spencer 1/16 in.]
Journ. New York Micr. Soc., II. (1886) p. 110 (2 pls.).

Schulze, A.—**The new Apochromatic Micro-objectives and Compensating Oculars of Carl Zeiss in Jena.**
[Cf. this Journal, *ante*, pp. 316 and 849.]
Engl. Mech., XLIV. (1886) pp. 126–7, 155.

Scribner, F. L.—**Method of making Drawings of minute portions of Plants.**
[The apparatus used consists of a Zentmayer dissecting Microscope, with the metal base replaced by a wooden one, which slides in a frame hinged to a heavy base-board. When in use, the frame is placed vertically and the focal distance adjusted as desired. A Wollaston camera and an adapter for lenses are attached; drawings are made on tracing paper and transferred by means of a steel point to Bristol board. The final lines are inked with Keuffel and Esser's pen No. 1459.]
Bull. Torrey Bot. Club, XIII. (1886) p. 170.

Sonnet—The Microscope.
["But here, in thee, frail instrument, we hold,
A more than fairy-fashioned key of gold,
That opes the boundless world Infinity;
And helps us trace, from its recondite source,
The first lace weavings of Life's dawning Now,
Down thro' its swiftly circling, onward course,
Till Man appears, with thought-enshrouded brow;" &c., &c.]
The Microscope, VI. (1886) p. 198.

Spencer Objectives and Quekett.

[Various letters as to the omission from the 2nd ed. of Quekett's 'Treatise on the Use of the Microscope' of the reference to Spencer's objectives inserted in the 1st.]

Amer. Mon. Micr. Journ., VII. (1886) pp. 197, 198.

Tursini.—**Apparecchio microfotografico.** (Photo-micrographic apparatus.)

[*Supra*, p. 1060.] *Il Morgagni*, 1886, p. 90.

Tyrrell, P.—**A 1/25 in. Objective.**

[Commendation of a Spencer 1/25 in., balsam angle 125°.]

Amer. Mon. Micr. Journ., VII. (1886) pp. 178–9.

Unna, P. G.—**Zur Histotechnik—Zerstreuende Diaphragmen.** (On Histotechnique. Dispersing Diaphragms.)

[Suggests for use with artificial light a ground-glass plate in the diaphragm-carrier. Dr. W. J. Behrens adds in a note (*Zeitschr. f. Wiss. Mikr.*, III., 1886, p. 230) that he prefers to use discs of dead blue cobalt glass, 2 mm. thick, ground on one side, placed with the ground side up, and illuminated with the concave mirror.]

Monatschr. f. prakt. Dermatol., V. (1886) No. 4.

Van Allen, J. F. C.—**200,000 to the Inch.**

["Many dispute the possibility of resolving lines ruled so finely as 200,000 to the inch. I can only say I have broken this reputable law repeatedly, and so have a dozen other reliable gentlemen"!]

Micr. Bulletin (*Queen's*) III. (1886) pp. 39–40.

Ward, H. M.—**The Morphology and Physiology of an Aquatic Myxomycete.**

[Contains a description, p. 73, of a moist chamber formed out of thick cardboard or several thicknesses of filter paper kept wet, a drop being suspended in a central cavity from the under side of a cover-glass. Also of the apparatus, *supra*, p. 1057.]

Stud. Biol. Laborat. Owens College, I. (1886) pp. 64–86 (2 pls.).

Westien, H.—**Doppel Objectiv-linsen mit gemeinschaftlichen Sehfelde.** (Double objective lenses with common field of view.)

Title of German Patent, Kl. 42, No. 4191.

White, T. C.—**On a simple method of Photographing Biological Subjects.**

[*Post.*]

Sep. repr. from *Journ. Brit. Dental Assoc.*, 1886, October, 8 pp. and 1 fig.

β. Collecting, Mounting and Examining Objects, &c.*

Cytodieresis of the Egg.†—M. J. B. Carnoy's paper on this subject is divisible into three sections, the germinal vesicle, the first polar globule, and the second polar globule, and accordingly the methods of examination fall under two heads.

In the study of the germinal vesicle and the nucleolus, the two following methods were employed—(1) Methyl-green in combination with 2 to 3 per cent. acetic acid, if possible on fresh objects, or on objects which had been fixed by a reagent which neither deteriorates the effect of the staining medium nor the constitution of the nuclein elements. (2) The use of solvents for the nuclein and also for the albumen corpuscles. Methyl-green is a specific reagent for the nuclein of the nucleus for the following reasons: methyl-green only stains the

* This subdivision contains (1) Collecting Objects; (2) Preparing, (*a*) in general, (*b*) special objects; (3) Separate processes prior to making sections; (4) Cutting, including Imbedding and Microtomes; (5) Staining and Injecting; (6) Mounting, including preservative fluids, cells, slides, and cabinets; (7) Examining objects, including Testing; (8) Miscellaneous matters.

† 'La Cellule,' ii. (1886) p. 76 (4 pls.). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 244–6.

nuclein within the nucleus; it leaves the membrane, the karyoplasma, and the plasmatic nucleoli unstained; whereas carmine, logwood, anilin violet, safranin, &c., are only uncertain reagents, for these stain all nuclear elements indifferently, the plasmatic nucleoli, perhaps, even more intensely than the nuclein. The solvent used for the albuminoids, as vitellin and myosin, were 0·001 per cent. hydrochloric acid, and 0·1 per cent. salt solution. The micro-chemical characters of nuclein given are: the nuclein substances are almost insoluble in water, insoluble in dilute mineral acids (partially soluble in strong acids), but easily soluble in very dilute alkalies. In a solution of sea-salt they swell up, forming a gelatinous mass. They present, with iodine, nitric acid, and Millon's reagent, the reactions of the protein substances. All these properties enable the nuclein substances to be easily distinguished from lecithin and albuminoids. It is, perhaps, owing to the nuclein that nuclei stain with picrocarmine.

For the study of the polar globules, fresh and preserved material was employed. (1) A small piece of an ovary was placed in a drop of methyl-green on a slide. The egg was then fixed (*a*) with 3 per cent. nitric acid, 50 and 70 per cent. alcohol, after Van Beneden's method. Instead of leaving the eggs two hours in 50 per cent. alcohol in order to obtain karyokinetic figures, the author merely washed with 50 per cent. alcohol until all the acid was removed, and then treated with 70 per cent. alcohol; (*b*) with absolute alcohol, to which a quantity of sulphuric acid was added. A large drop of this spirit is then run over the eggs on the slide until the methyl-green is quite decolorized; then the acid is carefully washed away; next glycerin or Ripart's fluid plus a little glycerin is added to the preparation. (2) For fixing and hardening ovaries intended for later use, these were treated (*a*) with 3 per cent. nitric acid; (*b*) with sulphuric acid alcohol, in which the objects are left for one to eight hours, according to the thickness of their membrane; after having been well soaked the objects are transferred to strong spirit; (*c*) The solution of mercury perchloride according to Gilson's formula may be used. The ovaries remain herein for 20 minutes to an hour, are then well washed in water and preserved in alcohol. In any case the eggs are stained with methyl-green. Of all the reagents sulphuric acid alcohol gave the best results.

Preparing Spermatozoa.*—For making permanent preparations of spermatozoa Mr. A. C. Cole says that no method succeeds better than receiving the perfectly fresh seminal fluid into a watchglass containing glycerin diluted with its own bulk of water, and a single drop of osmic acid solution. After mixing gently by means of a needle, drops of this fluid may be taken up by means of a pipette, deposited on slides, covered, and secured with gold size. By this method spermatozoa are mounted in a fluid of about the same refractive power as the natural seminal fluid, and appear as in life. The whole cell is preserved unaltered, except that its contour is slightly sharpened and the nucleus brought into greater prominence.

* Cole's 'Studies in Microscopical Science,' iv. (1886), Sec. 2, p. 6.

Another useful method of preservation is to receive the fresh semen on a slide, and spread out a thin layer by drawing another slide through it, over the glass. This film is then set aside for ten minutes, or until perfectly dry. A solution of eosin is then applied and left on the slide five or ten minutes, after which the excess of staining reagent is washed away by gentle agitation of the slide in clean water. It is again allowed to dry perfectly. A drop of Canada balsam is then applied, and covered as usual. This is a very simple method, and may advantageously be had resort to when it is desired to photograph the spermatozoa, the red stain giving the needed photographic opacity. But the cells are of course shrunken and distorted by this method, and only their coarser features can be preserved.

Demonstrating the mucous secretion of the skin of the Trout Embryo.*—Dr. L. Merk recommends for the study of the secretion of goblet cells, the embryo of the brook trout in which the epithelium on the body and on the yolk-sac is crowded with these forms. The embryos are available from the time when the eye-points appear. The smaller animals can be examined in water in a hollow ground slide, but the author preferred to cut the yolk-sac and isolate the investing membrane by waving it to and fro. The separation of the yolk-sac was undertaken in 0·75 per cent. salt solution because the issuing yolk is not precipitated therein, while in water an albuminous body (ichthin) is deposited. The membrane is carefully spread on a slide and examined in 0·5 per cent. salt solution or in water.

Preparing Cells of the Vitreous in Cyprinoids.†—Dr. H. Virchow gives the following directions for demonstrating the branched cells found on the surface of the vitreous in Cyprinoids:—(1) Hardening. Chromic acid, 2 per cent., Müller's fluid or 1 per cent. sublimate solution. The latter to be warmed to 30° C., and while cooling the preparations freed from sclerotic and choroid, should remain therein for about seven hours. After-treatment with alcohol is not requisite. Gold treatment is inapplicable as it renders the retina inseparable. (2) Staining. Slow staining with hæmatoxylin (followed by immersion in 1/2 per cent. alum solution) and eosin (eosin 1, alcohol 60, water 160) for twelve hours or more; transfer to absolute alcohol. (3) Mounting. After hardening in sublimate the preparation is spread on a slide and a cover-glass imposed; it is then transferred to alcohol and removed along with the cover-glass for further treatment.

Preparing Elastic Tissue of the Skin.‡—Dr. P. G. Unna demonstrates the elastic tissue of the skin by combining osmium-hardening with staining in an acid solution of dahlia or iodine violet. The solution is as follows:—dahlia, 0·2; aq. dest. and spirit (95 per cent.), āā, 10·0. Mix and add acid nitric, 2·0; aq. dest., 18·0; spirit 95 per cent., 10·0. The osmium sections are over-stained

* SB. K. K. Akad. Wiss. Wien, xciii. (1886) p. 28 (2 pls.).
† Arch. f. Mikr. Anat., xxiv. (1884) pp. 99–113.
‡ Monatschr. f. Prakt. Dermatol., v. (1886) No. 6.

in this solution for 12 to 24 hours, and according to its intensity the colour is extracted by acetic acid, or water acidulated with acetic acid. The sections are then to be washed and examined in glycerin, but permanent preparations are mounted in balsam. Over-staining with osmic acid is removed with peroxide of hydrogen.

Preparing the Iris.*—Dr. O. Eversbusch employs the following contrivance for examining the muscular tissue of the iris in Mammalia.

Liver, amyloid for choice, is hardened for five weeks in Müller's fluid, and after careful and prolonged dehydration in alcohols (up to absolute) is passed through, seriatim, the alcohol-clove-oil mixture, oil of cloves, turpentine, paraffin mixture, and lastly Merck's paraffin. Then a piece about 0·5 cm. thick is imbedded in a composition of hard and soft paraffin, and having been placed on a microtome (Katsch) is planed smooth. On this smooth surface the iris soaked in paraffin is placed and covered with fluid paraffin.

The author recommends that the iris should be stained *in toto*, and advises picrocarmine, hæmatoxylin and Grenacher's alum-carmine, giving preference to the last. If the preparation be too highly coloured the nervous elements are liable to be confounded with the muscular; therefore the tint should not exceed a light rose.

Preparing Spinal Ganglia of the Frog.†—Dr. M. von Lenhossék recommends the ganglia, of which the seventh, eighth, and ninth are easiest of access, to be placed in a 1 to 1·5 per cent. osmic acid solution, wherein they remain for three-quarters of an hour. Preparations were made both by section and teasing out. The hardened objects were imbedded either in Flemming's transparent soap or in Schiefferdecker's celloidin. Dissociation of the ganglia exposed merely to the influence of osmic acid did not produce satisfactory results. The author recommends objects treated with osmic acid to be placed afterwards in a mixture of equal parts of acetic acid and glycerin. The action of the acetic acid on the interstitial tissue may be increased by exposing the fluid with the ganglia for a day to a constant temperature of 35°–40° C.

Preparing Eyes of Heteropoda.‡—Dr. H. Grenacher recommends for the preservation of the eyes of Heteropoda, when intended for after examination, the use of Kleinenberg's picro-sulphuric acid mixture. A mixture of picro-sulphuric acid with sublimate, which had been so useful in the examination of retina of Cephalopoda, was here useless. The employment of the former medium with consecutive extraction with alcohol, led through irregular crumpling to destruction of opposing layers of single parts, occasionally to loss of continuity.

For the removal of pigment, Grenacher uses the hydrochloric acid which rendered good service in the Cephalopoda (2 or 3 parts to 100

* Deutsche Zeitschr. f. Thiermed. u. Vergl. Pathol., xi. Zeitschr. f. Vergl. Augenheilk., iii. (1885) pp. 25–32. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 251–2.

† Arch. f. Mikr. Anat., xxvi. (1886) pp. 370–453 (2 pls.).

‡ Abh. Naturf. Gesell. Halle, xvii. (1886) 64 pp. (2 pls.).

of a mixture of 1 part glycerin and 2 parts 80 per cent. alcohol). Both the quantity and the time are greater than is required for the Cephalopods. For the isolation of the membrana limitans and the recognition of the connection of the nerve-fibres and the retina cells a strong action of the bleaching mixture is required. The sharpness of the contours of the retina cells is said to be retained by mounting the preparations in castor oil, and the isolation of the membrana limitans is accelerated by transferring the bulb from the acid to weak spirit (about 50 per cent.). By this treatment the vitreous body and the lens swell up, while the membrana limitans remains unaffected.

Preparing Spermatic Elements of Cockroach.*—Prof. v. la Valette St. George recommends for the examination of the spermatic elements of the small cockroach (*Blatta germanica*) a fluid which unites the properties of not being harmful to cells, and that of staining certain cell-parts deeply. This is iodized serum, rubbed in with dahlia and filtered. The amniotic fluid can thus be replaced by another indifferent fluid. Dilution of pure nuclear-staining media with iodized serum did not give favourable results. For fixing the tissues the author used the mixtures recommended by Gilson and Carnoy, and with the same result, and also Flemming's fluid.

Preparing Acœlous Rhabdocœla.†—M. Y. Delage, as reported *ante*, p. 790, has demonstrated the presence of a distinct nervous system in acœlous Rhabdocœla, the absence of which has hitherto been considered as characteristic. His methods are as follows:—

1. Staining with gold chloride. (*a*) Examination of the whole animal. Fresh *Convoluta* are placed in a watchglass filled with sea-water. The greater part of the latter is removed and replaced by one-third formic acid. After two minutes the formic acid is displaced by a copious quantity of a 1 per cent. solution of gold chloride acting for 10 to 12 minutes. From the gold solution the *Convoluta* are transferred to a 2 per cent. solution of formic acid in which they remain in the dark for one to three days. The progress of the reduction of the gold must be watched. The author considers it to be advantageous to allow the staining to proceed to complete violet or even non-transparency and to decolorize slowly by means of a 1/2 per cent. solution of cyanide of potash (2 to 24 hours). The effect of the last reagent is interrupted by a 2 per cent. solution of formic acid. By this treatment all the tissues are stained violet, the nervous system first, as it is the last to be decolorized. Mount in glycerin or balsam.

(*b*) If the author intended to cut the animals, he crushed them gently on a slide and allowed some one-third formic acid to run under the cover-glass. This altered the form of the *Convoluta* as little as possible and kept them extended. Further treatment was as above. From the 2 per cent. formic acid, the author passed them into 60 or

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 1–12 (2 pls.). See this Journal, *ante*, p. 590.

† Arch. Zool. Expér. et Gén., iv. (1886) pp. 109–60 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 239–41, and this Journal, *ante*, p. 796.

70 per cent. alcohol for a quarter of an hour; half an hour in 90 per cent. alcohol, and three to four hours in absolute.

Imbedding in paraffin. Unfortunately this method is uncertain, and does not allow the finer structure of the nervous system to be studied. The zoochlorella retain, and this is a great advantage, their green colour.

2. After the author had convinced himself of the existence of a nervous system, he tried many dyes without result, but attained his object by the simultaneous action of osmic acid and carmine. For this purpose he heated a strong solution of carmine in ammoniated water in a water-bath until red clouds on the surface of the purple fluid arose. This shows that the excess of ammonia has disappeared. After cooling, an equal volume of a 1 per cent. osmic acid was added to the carmine solution, and filtered under a bell-jar. A red fluid, smelling strongly of osmic acid, was obtained, and this served at once as a fixative and staining agent. The animals, placed alive in the fluid, remain there for a half to twelve hours, and are then transferred to 90 per cent. and finally to absolute alcohol. After some days the osmic acid odour disappears and along with it the fixative power, but the staining capacity of the fluid remains undiminished. It is then necessary to fix objects to be examined in a 1 per cent. osmic acid for two to ten minutes. The staining is as follows:—The cell plasma is but slightly stained; the cell membrane stands out sharply, the nuclei and nucleoli appear red or rose. Fat-drops are black or grey; the cilia a pale red. The zoochlorella retain their greenish hue.

The author found iron sulphate to be an excellent fixative. In a concentrated solution the animals die extended without change of form. In order to save time, six to twelve *Convoluta* were cut at once. With this intent the *Convoluta* are taken from the paraffin dissolved in chloroform, to a glass plate coated with a thin layer of oil, and arranged as desired. The plate is then placed carefully in a bath of tepid paraffin, and after cooling, the whole are cut together.

Preparing Rotatoria.*—Dr. L. Plate, in his researches on the natural history of the Rotatoria,† used the following methods:—

The animals are immersed for 10 to 15 minutes in a 1 per cent. solution of osmic acid; they are then washed and transferred for a day to a 2 per cent. solution of chromate of potash, after having been well washed they are stained for 2 to 24 hours in borax or picrocarmine. Then alcohol with hydrochloric acid, and finally 60 per cent. alcohol.

To obtain the animals with extended wheel apparatus, the author used (1) a saturated solution of picro-sulphate of potash, 1 part, and water 40 parts. They are then placed in a watchglass filled with the fluid, which (2) is heated until bubbles appear. A few unfolded examples will always be obtained.

Mounting Spicules of Gorgonia.‡—Mr. A. C. Cole states that to make nice slides of spicules of *Gorgonia* a portion of the *Gorgonia*

* Jen. Zeitschr. f. Naturwiss., xix. (1885) pp. 1–120 (3 pls.). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 239. † See this Journal, *ante*, p. 76.

‡ Cole's 'Studies in Microscopical Science,' iv. (1886) Sec. 4, p. 7.

must be boiled in liquor potassæ. When the axis of the skeleton is left bare the detached and clean spicula are to be poured off into a large test-tube and washed over and over again in distilled water until all debris is got rid of; they are then to be dried and put into perfectly clean dry bottles. A thin glass cover is to be cleaned, and a solution of 12 to 15 drops of strong gum-water in 1 oz. of distilled water (filtered) is to be prepared, and a drop of this spread carefully over the cover and *allowed to dry* (not dried by heat), put away under a glass shade, or in a case impervious to dust. When the gum solution is dry it is to be breathed upon until the surface is quite moist, and a piece of fine muslin, which will just allow the spicula to pass through its texture, being strained lightly over the neck of the bottle the spicula are to be scattered evenly (as from a pepper-castor) over the adhesive surface; after a minute the cover is to be taken up by means of forceps and tapped upon a sheet of paper until all non-adherent spicula are shaken off, when balsam is to be applied.

"Dry" mounts of spicula may, of course, be made in the same way; the cover, with the spicula attached to it, being secured to the bottom of the cell. The advantage of this method is that the spicula are firmly attached to the cover, and all lie upon one plane.

Preparation of Anthozoa.*—Prof. M. Braun has made some experiments on *Alcyonium palmatum*, *Caryophyllia cyathus*, and other Anthozoa; he treats them with a concentrated solution of corrosive sublimate in sea-water, which he boils, and to which he then adds four or five drops of a 1 per cent. solution of osmic acid to 20–25 c.cm. of the solution; this is suddenly poured over the Anthozoa. After five minutes the fluid is drawn off, and the specimens washed with sea-water, and then gradually treated with alcohol, beginning with 30 per cent., and ending with alcohol of 96 per cent. solution. *Hydra*, rotifers, and Polyzoa may be treated in the same way, and then preserved in Canada balsam, or be imbedded in paraffin and cut into sections; the preservation of the tissues will be found to be perfect.

Prevention of browning in Plant Preparations.†—Dr. H. de Vries finds that the browning of vegetable preparations depends on the reduction of certain colourless substances (chromogens) by the oxygen of the air. In order to prevent the appearance of this brown staining the air and chromogenous substances are removed, the former in boiling alcohol, the latter by extraction in acidified solutions of spirit in water. The latter solution is preferable for most leaves and stalks, the former for thin delicate leaves and for flowering parts. The acids used are sulphuric or hydrochloric in 2 per cent. solution, and the treatment lasts for some hours to several days.

To remove the brown stain from vegetable preparations the author employed the following solution:—100 c.cm. spirit, 0·2–0·5 strong

* Zool. Anzeig., ix. (1886) pp. 458–9.

† Maandbl. voor Natuurwetensch., 1886, No. 1 (7 pp.). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 280–1.

sulphuric acid, and a few crystals of chlorate of potash. Stronger solutions had no greater effect.

Preparing Fucus vesiculosus.*—For the demonstration and fixation of the cells of the filaments on which the spermatozoid cells exist as end-cells, Dr. J. Behrens used osmic and picro-sulphuric acid, also iodine water and bromide vapour, and for staining, Schneider's acetic-carmine. For the observation of nuclear fission in the antheridium cells, carmine staining is not especially favourable. The processes in the spores and perispores must be studied in fixed material; picro-sulphuric acid, bromide vapour, iodine water, boiling water, chrom-osmic-acetic acid serve as fixative media, and in rare cases alcohol and 1 per cent. acetic acid. Bromide vapour and boiling water are the most convenient agents as they do not necessitate any washing out afterwards. After staining, the objects are placed in dilute and finally in absolute alcohol. When perfectly dehydrated, they are cleared in clove or turpentine oil, and mounted in balsam or dammar.

In order to render visible what had happened in the spore after the penetration of the spermatozoids (occurrences hitherto unobserved and invisible in the living spore by reason of its opacity), the author mixed fresh spores with spermatozoids in a hollow ground slide, and after some moments the spores were killed, usually with iodine solution, and then stained and cleared up.

Separating Desmids, Diatoms, and other minute objects.†—Mr. C. L. Wilbur uses for separating desmids and similar objects from the foreign matter with which they are associated in nature, a set of suction-tubes, five in number, increasing and decreasing in fineness from No. 3, which is large enough to comfortably admit a *Cosmarium tetraophthalmum*. These are ranged on a small wooden rack placed on a box of convenient size at the right of the Microscope and are fitted in, as needed, to a small flexible white rubber tube; this fits over one of two glass tubes put tightly through the stopper of a 1-oz. wide-mouthed bottle, and to the other tube is fitted a second one of rubber which is held in the mouth while at work or fitted to a convenient mouth-piece. The tubes are filled with water on beginning work to a height sufficient to satisfy capillary attraction. Then, working e.g. under a 1 in. objective and B eye-piece, the point is brought nearly to the surface of the pool on the slides and moved to and fro horizontally till shadow is seen in the field, thence quickly brought with the point close to the object. After a little practice the proper point can be inserted and instantly brought to the object without taking the eye from the field. It can now be sucked in and transferred to little pools of 50 per cent. glycerin on a collecting slide, parcelling off like forms, different sizes, &c., or, by alternately expelling and drawing in the breath, the object can be rolled over and over by the current from the tube, thus showing all sides.

The author ordinarily takes samples with a small pipette, places

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 92–103.
† The Microscope, vi. (1886) pp. 169–71.

them on the slide and spreads out and breaks up foreign gelatinous masses with a curved glass needle set in a match-stick as a handle. It is useful to give a preliminary running over with 50–100 diameters for larger forms, and then, taking care that the pool is shallow enough to avoid contact with the objective, and occasionally replacing water lost by evaporation, run down with 1/4 in. or 1/8 in. objective and take out the smaller species. Finding, for example, a *Pediastrum tetrus* or small *Cosmarium* under the higher power, turn on the 1 inch (a nose-piece is indispensable), run back, remove the small speck and place him in the little pool containing his brethren that have gone before him. *Docidium* and long strings of filamentous desmids are safely taken up by holding the tube in the direction of their length and expelling them with the tube held nearly horizontal to avoid injury from flexure. A very little experience will enable the beginner to transfer with certainty, ease, and rapidity any object he can make out under 250–500 diameters.

This method is of course equally applicable to separating diatoms or any minute objects which it may be desirable to preserve. Mosses, &c., too large to enter the tubes can be sucked against their ends and there held while being transferred. Further, in microchemistry, minute crystals can be taken up from plant sections, moved to a clean portion of the slide (or better, to a piece of thin cover-glass held in a match-stick handle which admits the application of heat when needed) and then treated with solvents, &c. For the use of reagents, in order to avoid the undue multiplication of tubes and the contamination which would result from using the same tube for more than one reagent, the author uses little *test-points*—formed by drawing out small glass tubing—with bulging body and short tapering shank, which is inserted in a small hole passing through a cork stopper, which closes a glass tube (3 in. × 5/16), the other end of which is drawn out and cut off to admit of substitution for a fishing tube. The points are kept on a convenient tray or large watchglass, and being charged with various liquids, permit the ready and perfectly controllable application of any test or stain to very small quantities of matter. Precipitates can be formed, redissolved, &c.

The desmid tubes, test-points, &c., can be fashioned by any one after a few minutes' practice from small glass tubing by aid of the blow-pipe. A common kerosene lamp furnishes a good enough flame for the purpose. To prevent blackening of the tubing (containing lead) it must be kept out of the inner, luminous reducing flame.

Collection and Treatment of Living Diatoms.*—Herr E. Debes recommends the following articles as the necessary equipment when in search of diatoms :—A bag or travelling satchel; a number of wide-necked glass bottles, with glass, cork, or caoutchouc stoppers. These should be of two sizes, the larger, 1/3–1/2 litre, the smaller 1/6–1/4 litre; a flat 4–6 in. net of thick gauze, fine book muslin, or any other not too coarse tissue; a tin spoon fitted with a screw, as well as a telescope-stick, if possible, to which both can be screwed on. Also

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 27-38.

an ordinary metal spoon, and most important of all, a Thum's "Algen-sucher" pocket Microscope, which has a magnifying power of 150–180 times, with the necessary glass plates and some linen rags for cleaning them. Parchment-paper and guttapercha will also be found useful for packing up things. It is scarcely necessary to say that owing to the habitat of diatoms waders may be needful.

Collection should be made, if possible, on a summer day. Water plants, stones, and any other substances seen lying in water, especially in early spring, are to be carefully scrutinized for a brownish-coloured coating. If the Microscope reveal their yellow cell contents, the brownish layer may be removed with the finger to the collecting bottle. When the diatoms are found as a soft brownish or blackish scum on the water bottom, this is scooped up with the net, and after draining, is removed with the spoon to the collecting bottle.

The coarser impurities are removed from the material thus collected by straining through a hair sieve into flat vessels, so as to produce a layer of 1½ to 2 cm. This is set aside in a cool, shady place and covered over with about 1 cm. of water. In one or two days the surface of the muddy layer will be found covered with living diatoms, while the dead and certain varieties unaffected by light, remain buried in the mud. This characteristic may be taken advantage of to procure a pure cultivation of diatoms by merely placing the vessel in the sunshine, when in a short time the diatoms struggle to the surface, forming a delicate scum, which is easily removed for examination or for preservation in alcohol. If the residue is required for further cultivation it is supplied with fresh water, and then placed aside in a cool and shady place. Those forms which do not rise to the surface, but are disseminated throughout the mud, are to be obtained for examination by boiling the residue with clean water and decanting off the fluid.

Another method, which gives better results, but which requires more time, is, after the sifting and the development of the diatoms, to decant off the water, and then keep the mud surface moist by spraying. In four to six days the mud layer has become so consistent that the diatoms may easily be stripped off the surface with a brush. Certain species adhering to water plants, stones, &c., are obtained by sifting from larger impurities, and allowing the water to settle, only brushing the diatoms off. These are preserved either with the objects on which they are found, or the whole collection may be boiled with dilute nitric or hydrochloric acid, and then filtered off to be preserved in the usual way.

For the cultivation of diatoms it is only required to place the mud collections in flattish vessels in a cool airy place, sheltered from the sun, and covered with a thin layer of water. A constant change of water, the stream of which must not be too strong lest the diatoms be washed away, and kept at a level of 1 cm. high, is extremely useful to the cultivations, which, with care and attention, will last for an indefinite period. About every 14 days it is necessary to stir up the mud layer thoroughly, in order to bring the diatoms into contact with

fresh layers, and it must be always kept in mind that once allowed to dry the whole cultivation is ruined.

In most cultivations a constant change of the varieties takes place, one form driving out another, and this in its turn being supplanted by a new variety. As a rule the more motile forms spread over the less mobile, and the former may therefore be easily removed by means of a brush.

Mounting Diatoms.*—Señor A. Truarn y Luard gives, in his work on the diatoms of the Asturias, a new and original method for mounting.

Egg-albumen is mixed with its own weight of distilled water, and with 5 grms. of pure ammonia. The mixture having been beaten to frothing, is allowed to stand for 12 hours. The clear fluid is then decanted, filtered, and preserved. The addition of ammonia prevents decomposition for a period of one or two months. Coating the cover-glass with the fluid, arranging the diatoms, and fixing them by breathing over them, is performed with exactitude by the use of this gelatin solution. To close the preparation, the cover-glass is placed on a metal plate, and heated to a degree sufficient to coagulate the albumen. Preparations obtained by this method are extremely clear and brilliant.

Mounting Isthmia.†—Mr. R. Hitchcock, in reference to a remarkably pure gathering of *Isthmia nervosa* attached to seaweed, points out that by the exercise of some skill and patience their natural beauty may be brought out far better than is often seen; and he remarks that there is "a fine art in mounting microscopic objects that many of the more stolid investigators affect to despise; but so long as the specimens are not distorted, misshapen, or crushed out of their natural condition, they lose nothing for purposes of study by being skilfully prepared for exhibition."

The usual method of mounting *Isthmia* is by drying the frustules, either on the seaweed or, freed by shaking, on an opaque ground. In this way, exercising some care in selecting the most showy groups, very attractive specimens can be obtained. A dry mount of the free frustules can be greatly improved by previously clearing them, or rather removing the dried endochrome. The best way to do this is to place them for a few minutes in a bleaching solution which may be chlorine water, Labarraque solution, or any such active agent. No acid is required. In the course of fifteen minutes the frustules will probably be quite white, and, owing to the air contained in them, they will form a perfectly pure layer floating at the top of the fluid. It is then only necessary to remove the solution below by means of a pipette or siphon, wash several times with water, drawing it off in the same way, and finally collecting the diatoms in a bottle with some alcohol for preservation. They are now perfectly clean, and white as snow.

To prepare a dry mount select a clean cover-glass and place a

* An. Soc. Espan. Hist. Nat., xiii. (1884) pp. 307–64 (4 pls.).
† Amer. Mon. Micr. Journal, vii. (1886) pp. 148–9.

sufficient number of the cleaned diatoms with water upon it to form a perfectly even layer of the diatoms over the central part of the cover. As the water evaporates the frustules will gather close together and form a compact mass in a single, uniform layer, perfectly adapted for a display slide. An exceedingly thin and clear solution of gum may be used in this operation to attach the frustules more securely. When thoroughly dry, cement the cover-glass over a ring, just deep enough to protect the diatoms, preferably with a dead black bottom.

This particular diatom, however, is a far more brilliant object when mounted in balsam and viewed with a dark field. It is likewise one of the most difficult to mount in balsam, owing to the persistence with which the air is retained within the frustules. A mount in balsam of the diatoms attached to the seaweed as they grow can be made by the method devised by the late Charles Stodder. Selecting a perfectly dry specimen, place it in chloroform for a short time, and, if necessary in order to remove all the air, heat the latter gently. In this way the frustules become filled with the liquid. Then place some drops of chloroform on a slide, transfer the specimen selected for mounting to this, and keep it covered with the liquid. It is well to put on a cover-glass to prevent rapid evaporation of the liquid. Then add chloroform balsam and let it run under the cover and follow the chloroform as it evaporates from the frustules, aiding the operation with gentle heat. In this way the hollow frustules can be completely filled with balsam without difficulty, and the mounts thus obtained are very fine.

In mounting the free frustules in balsam we have adopted a plan somewhat different in detail, in order to obtain a perfectly flat and even layer of frustules against the cover-glass. The cleaned specimens in considerable abundance were first placed in chloroform in a small vial, and raw, hard balsam added until a not very thick solution was obtained, which thoroughly permeated the cells. The solution was poured upon a cover-glass resting on a mounting table, with a spirit-lamp beneath. In a short time the frustules settled down upon the cover-glass and formed an even layer. The closer they are the more effective the result. Heating now, very gently indeed, the balsam becomes slowly hardened without distributing the diatoms. If necessary, more balsam can be added, but if possible, a sufficient quantity should be put on at first, as the addition of more is likely to disarrange the specimens. The balsam must be thoroughly hardened, without heating enough to discolour it. We now have the frustules nicely mounted in the balsam on the cover-glass, and the latter may now be turned over and attached to a ring on a slide, and the mount thus finished. It will be greatly improved, however, by the well-known process of backing with black varnish. First put on a layer of shellac over the balsam to protect it from the action of turpentine, and then apply an opaque layer of black varnish. When this is thoroughly dry, mount the cover-glass on a ring, and it will make one of the finest objects in any cabinet.

Micro-chemical reactions of Lichens.*—Dr. E. Bachmann has made some preliminary micro-chemical experiments on lichens for the purpose of obtaining from the pigmented parts reactions which may be applied as tests for determining the position of these cryptogams.

The black apothecia of many crustaceous lichens he finds is due, not to one black pigment, but rather to four different pigments, one brown and three blue or green-blue. These are distinguished by certain characteristics which are epitomized thus:—

A. If the addition of potash solution causes little or no change in the pigment, but (*a*) when nitric acid is added to excess a copper-red coloration, confined to the surface, results, this shows the presence of Blue i. (*b*) If, however, on the addition of the nitric acid a violet hue penetrating as far as the colourless hymenium results, then Blue ii. is indicated.

B. If the addition of the potash solution is followed by the appearance of a deep violet colour, then Blue iii. is present.

The author's method consists merely in treating sections of the apothecium with a potash solution or some other strong base, then over-saturating with nitric acid, and lastly, allowing a solution of calcium chloride to flow under the cover-glass (strength of solution not given). The reaction is also obtainable from crushed preparations, provided that the sub-hymenial tissue is not pigmented.

Demonstrating Glycogen in the Basidiomycetes.†—Dr. L. Errera states that not only can the presence or absence of glycogen in Basidiomycetes be determined, but that by iodine staining the approximate quantity is also ascertainable.

The solution used is composed of H^2O, 45 grm.; iodide of potassium, 0·3 grm.; iodine, 0·1 grm. After placing a section in a large drop of this solution the cover-glass is imposed, a little water added, and then the slide heated until it feels rather hot to the hand. If glycogen be present in extremely small quantity, the coloration is rather orange than brown, and a somewhat more concentrated iodine solution may be used.

Demonstrating the Nucleus in Yeast Cells.‡—Dr. A. Zalewski demonstrates the nucleus by keeping the cells in water for some hours, and then treating with hæmatoxylin and alum solution. In ripe spores the nucleus is also easily shown. In budding and spore-forming cells the nucleus is not discoverable.

Imbedding Fish Eggs.§—Mr. J. A. Ryder's method of imbedding fish eggs which have been coloured *in toto* with borax carmine, or borax picrocarmine, is as follows:—

a. After dehydration with about forty times their own volume of

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 216-9.

† Mém. Acad. R. Sci. Belg., xxxvii. (1885) 50 pp.

‡ Verh. u. Ber. d. Krakauer Akad. d. Wiss., xiii. (1885). Cf. Bot. Centralbl., xxv. (1886) p. 2.

§ Ryder, J. A., 'On the preservation of Embryonic Materials, &c.,' 1884, p. 15. Cf. Whitman's 'Methods of Research in Microscopical Anatomy and Embryology,' 1885, pp. 101-2.

strong commercial or 97 per cent. alcohol, and afterwards saturated with oil of cloves, the embryos are placed in a watchglass containing a melted mixture of chloroform and paraffin in equal parts, in which they may remain twenty or thirty minutes at a temperature not above 150° Fahr. When saturation is complete, the eggs have the same appearance in the melted mixture as in alcohol.

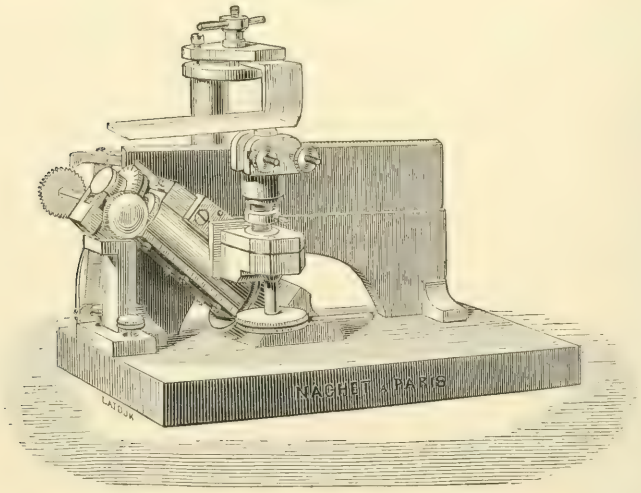
b. From the above they are transferred to another larger dish, containing pure paraffin, which melts at 158° Fahr., but which must on no account be allowed to boil. Here they remain for twenty to thirty minutes more.

c. The embryos are then transferred, one or two at a time, to a common slide, such as is used for mounting objects. The slide may be warmed over an alcohol lamp. A brass ring, 5 to 8 mm. deep, and 24 mm. in diameter, is then placed on the slide around the object. This ring is then filled with melted paraffin, and the object arranged in it in the desired position, with a hot needle, when the whole is left to cool.

d. After cooling, the paraffin contracts within the ring, when the latter may be removed, and the discoidal block may then easily be loosened from the slide. The block may then be trimmed down with a scalpel, into a shape suitable for fastening into the well in the carriage of a sledge microtome, or the block may be marked and laid away until it is wanted for use.

Nachet's Microtome.—This microtome (fig. 238) is distinguished

Fig. 238.



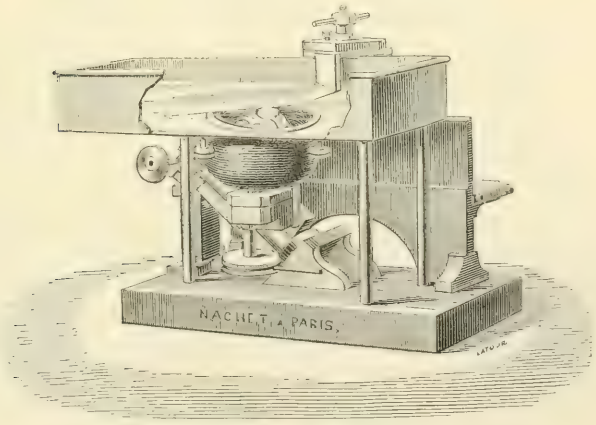
from previous models by several innovations. The knife-carrier slides on an agate plate and is provided with four points of agate to

reduce the friction; two fine rollers under the agate plate assure the perfect contact of the carrier with the sliding plane.

The object-carrier is attached to an elevator which is raised and lowered by the same mechanism as the slow motion of Continental Microscopes. This is inclined so as to reduce the elevation and allow of sections being made as fine as the knife will cut or the nature of the tissues will permit. Special mechanism prevents loss of time in the screw, and the thickness of the section is exactly indicated by graduations on the milled head. At each traverse of the knife the object is raised automatically as the knife-carrier strikes against the end of a lever-arm which catches in the teeth of the wheel shown in the figure, and which by means of a tangent screw at the other end of its axis turns the micrometer screw and raises the object 0·002 mm. If it is desired to raise the object to a greater extent the knife-carrier must be made to strike the end of the lever a second or third time, according to the height required.

The microtome can also be used to cut sections in alcohol by a very simple and entirely novel addition. A metal tray having an aperture in the centre, over which a piece of indiarubber is stretched, is placed on supports, as shown in fig. 239. The indiarubber is pierced

Fig. 239.



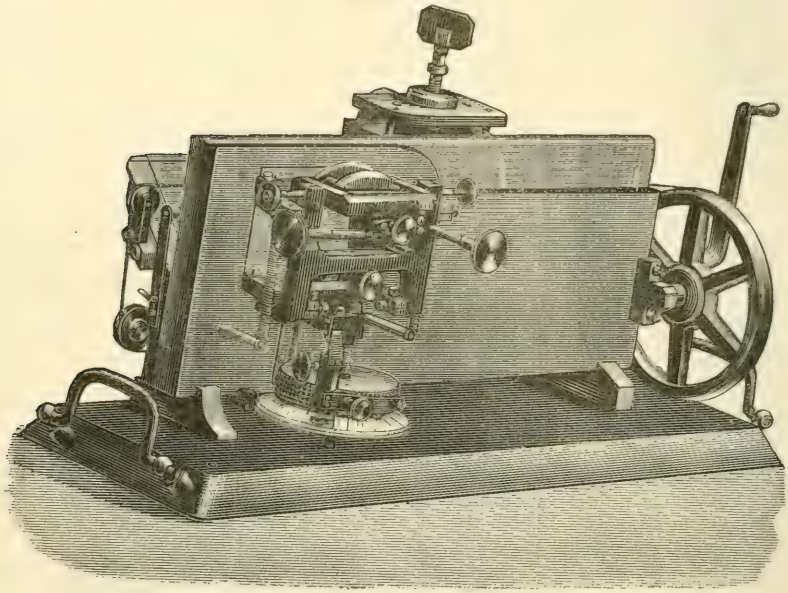
with a small aperture in which the vertical rod is applied which supports the object-carrier, the edge of the rubber is then clamped by a special arrangement which forms a kind of annular drumhead of it and prevents leakage of the fluid. The object does not project above the bottom of the tray which is filled with alcohol.

In order that the knife may work easily in the tray, the blade is set on an angle-piece so that it is 3 cm. below the handle. The movements are thus left quite free; the tray is in contact with the

elevator only by means of the piece of indiarubber, which is sufficiently elastic to allow of the few millimetres of play required by the slow motion. The object-carrier is a simple double screw vice; it is mounted on a ball-and-socket joint of diameter sufficient to provide an active surface of 12 square cm., by means of a tightening screw with lever, by which it can be rigidly fixed; and when the object to be cut is inclined, it remains always close to the axis of the clamping mechanism. The object-carrier may be readily replaced by a freezing-stage.

Schiefferdecker's New Microtome.*—Dr. P. Schiefferdecker's instrument, of which a general view is given in fig. 240, consists of a heavy stand A (fig. 241), upon which are two blocks B, supporting the plates D and C. The upper part of the latter forms part of the slide-way. Between C and D is interposed a thick glass plate E,

Fig. 240.



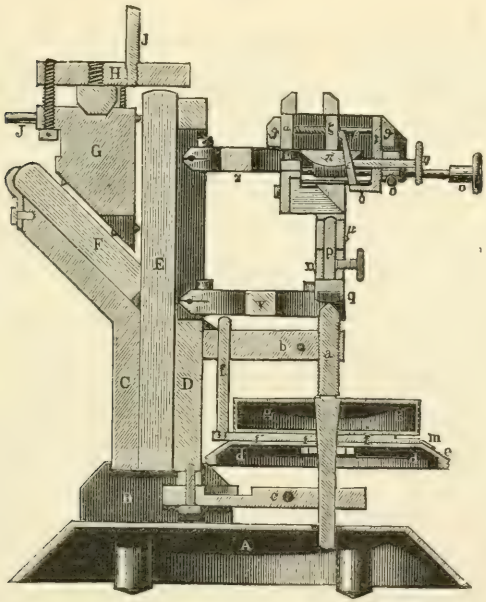
while on the oblique part of C is fixed a similar glass plate F. In the angle (45°) between E and F runs the body of the knife-carrier G, which is separated from the glass plates by ivory knobs, four to each surface. Above the body G is the knife-plate H, connected by three screws with G. This plate and the body are separated by a block for giving an inclination to the knife. The upper surface of the

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 151–64 (4 figs.).

plate H is seen (fig. 242) to be perforated by holes, the larger of which are intended for fixing the knife in different positions. The rods J J are for the purpose of supporting extra weights, to be attached when additional weight is required for the carrier, and the holes J′ in the plate (fig. 242) are for altering the position of the rods in case they interfere with the knife.

The apparatus for the object-carrier and its motor is somewhat

Fig. 241.

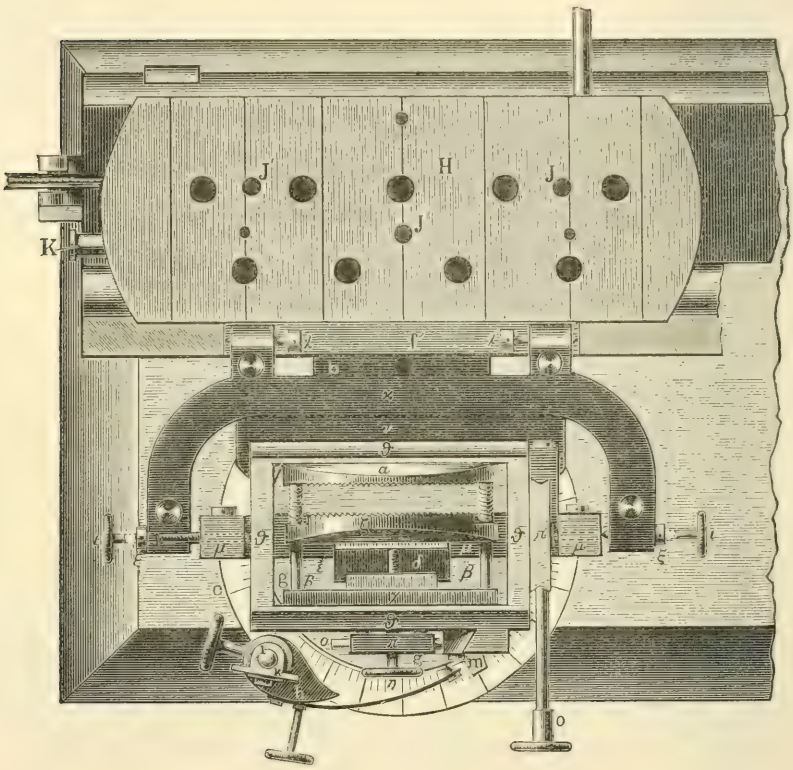


complicated. The section-holder $\alpha\,\zeta\,\gamma$ (fig. 242) consists of a clamp with two jaws $\alpha\,\zeta$, the serrations of which point to the left, in order to oppose the course of the knife. The bars β are fitted with spiral springs, and their action is opposed by the screw η working against the plate ϵ, which in its turn presses against ζ. The clamp is fitted within a quadrilateral frame θ, and the latter swings between the upper arms of an H-shaped piece μ through the intervention of the screws ι (fig. 242). The lower arms of μ are fitted to the front ends of a similar shaped piece ν, the hinder ends of which fit into a rectangular excavation of the middle plate D. Both these hinder arms are perforated by screws, the ends of which work against the sides of the excavation in D. The front ends of ν are screwed to the lower ends of μ. The C-shaped piece $\varkappa$ is fixed to the upper arms of μ by screws at ξ, while through its prolongations posteriorly the screws λ work against the sides of the excavation in D.

Now though the object-carrier can of course only move vertically, the clamp frame is provided with motion in two directions, viz. from side to side and from before backwards. These movements are effected through the mediation of the endless screws o working against a thread on the half-circles π (figs. 241, 242).

The micrometer-screw a, capable of moving 30 mm., is turned by

Fig. 242.



the large milled head d. This head is marked by 100 radial lines, and as one turn of the screw raises the object 0·5 mm., one division corresponds to 0·005 mm.

The pointed upper end of the micrometer-screw pushes against an agate plate q fixed to the lower end of a rod p, let into the cross-bar of μ; below the latter is a metal case n and a fixing screw. The lower end of a is in connection with the bars b and c, which in their turn are in apposition with D.

The drum *g* through which the micrometer-screw passes is marked by six lines of holes. A spring-catch supported by a vertical rod fixed to *f* snaps as the drum revolves.

Fixed to the extremities of *x* by one end, and by the other to a rod projecting from D, are two spiral springs for the purpose of keeping up the tension of the carrier on the micrometer-screw.

If desired, an arrangement for fitting the instrument for cutting under spirit can be applied, and also for raising the preparation automatically.

Efficiency of the Micrometer Screw.*—Prof. M. Gottschau in reply to Herr Ost's paper,† repeats his previous conviction that micrometers constructed with an inclined plane are not inferior, nay, are superior, to those in which the motion is vertical or lateral; the chief points in favour of the latter are that the knife can be used in its whole length, and that this construction is more convenient than one which necessitates the constant whetting of the knife. With these and other details, Prof. Gottschau does not agree. Dr. A. Brass, who recently made some remarks ‡ on the microtome knife and how to manage it, also shares in the author's strictures. The result of the matter simply is, that the one authority strops, and the other hones. In this connection we may remark that nearly all microtomists seem to differ on the treatment of knives, some advising soft stones, some hard, and with or without the use of the strop.

Use of Methylene-Iodide for Petrographical and Optical Purposes.§—Herr R. Brauns directs attention to the value of this substance both as a liquid for the separation of minerals of different specific gravities, and as a convenient medium for the determination of refractive indices by the method of total reflection. For the former purpose it is well adapted by reason of its high specific gravity (3·33), which is greater than that of Thoulet's solution, and almost equal to that of Klein's solution. The author finds the specific gravity to be 3·3485 at 5° C., and 3·3045 at 25° C., the variation being uniform. For the successive separation of lighter minerals the liquid must be diluted, not with water, but with benzole; it may be readily concentrated again by distilling off the benzole, and is purified by shaking with diluted potash water.

For optical purposes it is particularly fitted by its high index and by the fact that it is not decomposed or diluted by exposure; in these respects having a considerable advantage over Rohrbach's solution. The index of refraction for sodium light is 1·74873 at 5°, and decreases uniformly to 1·73453 at 25°, while the decrease in the index for each ray is equal for equal increments of temperature, but different for different rays, the dispersion (which is considerable) becoming less as the temperature increases.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 14–8.
† See this Journal, *ante*, p. 538.
‡ Ibid., p. 706.
§ Neues Jahrb. f. Mineral., Geol. u. Palaeont., ii. (1886) pp. 72–8.

Improved Whitney Section-Instrument.*—Mr. J. W. Queen has improved the simple section-instrument of Mr. J. E. Whitney, described *ante*, p. 539.

A block of walnut with a V-shaped cut or recess (fig. 243) is faced at one end of this recess with strips of plate glass of uniform thickness. It may be used thus without any screw, by holding the stem (or other object to be cut) in the recess with thumb or finger, and advancing it carefully by hand as the end is cut. For nicer work a screw with large milled head is added, which is clamped to the under side of the block in such a way that it may be shifted to set opposite to the centre of the object to be cut, whether large or small, and setting more or less deeply into the groove. There is a cap to fit over the end of the screw to give a broader bearing, and so prevent the screw from sinking into the tissue.

Fig. 243.

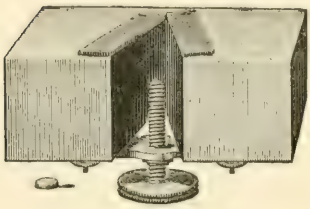
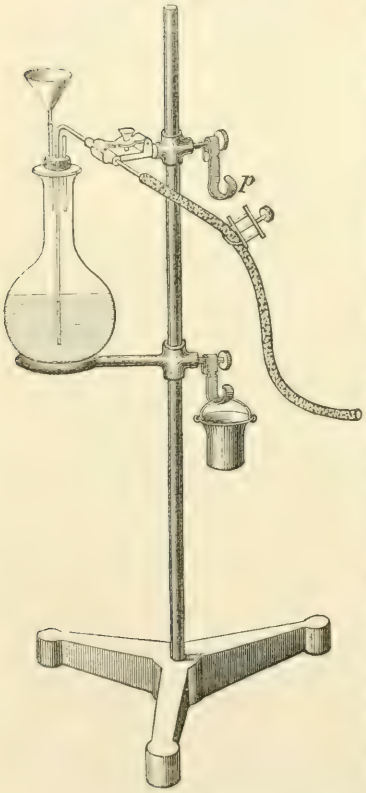


Fig. 244.



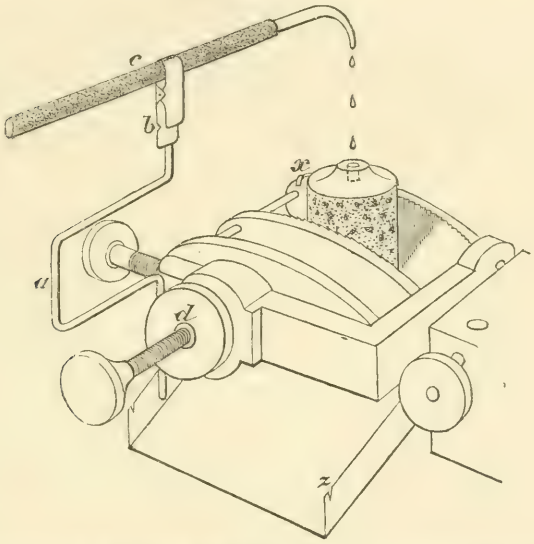
Alcoholic Drip for the Thoma-Jung Microtome.†—Mr. W. T. Sedgwick, in conjunction with Mr. G. E. Stone, has devised a very neat siphon drip for the Thoma-Jung microtome.

Constant pressure and flow are obtained by the apparatus shown in fig. 244. Fig. 245 shows the end of the flexible siphon tube *c*, fixed by a clip *b* to a stiff wire *a*. The wire is attached to the object-holder by the collar *d*, which is firmly screwed down. The overflow of spirit is carried off by a trough, which is suspended by a hook *x*. The trough fits underneath and behind the object-holder. The notches *z z* are to secure a wire from which a vessel is suspended beneath the trough to catch the overflow. When not in use the tube and wire are hung upon the hook *p* (fig. 244).

* Micr. Bulletin (Queen's), 1886, p. 30 (1 fig.).
† Amer. Natural., xx. (1886) pp. 488–90 (3 figs.).

The convenience of the drip consists in the fact that, being attached to the object-holder, a constant flow of spirit is poured over the object.

Fig. 245.



Schällibaum's Fixation Method.*—Dr. H. Schällibaum has made some improvements in his method for fixing sections to the slide for the purpose of subsequent staining. The alteration occurs after the ethereal oil has been driven off. Then if the object has been imbedded in paraffin, a few drops of xylol are poured over the slide, held obliquely, until the paraffin is completely removed. The xylol in its turn is replaced by 95 per cent. alcohol, and the slide and section are carefully dried. They are then placed in a water-bath in order to completely remove the alcohol.

If the sections have been imbedded in soap, gelatin, gum, albumen, celloidin, or any other alcoholic or watery medium, the slide, after the ethereal oil has been evaporated, is placed for 15 minutes in a 95 per cent. alcohol bath and thence into water, where it remains until all the alcohol is driven off. (An intermediate step between the water and alcohol is advised both for the above and for the paraffin imbedding. It consists in breathing over the dried section several times.)

Staining is always carried out in the same way. After the section has been dried, some drops of the staining fluid are poured on and left until the desired colour is attained. The slide is then placed in a moist chamber to prevent precipitation of the fluid from evaporation. All the ordinary stains, except picro-carmine, may be used, but the

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 209-11.

best is Grenacher's hæmatoxylin. After having been stained the sections are carefully washed and mounted in glycerin or some watery medium.

If it be desired to mount in a resin, the slide is placed in 95 per cent. alcohol for 15 minutes, the section is then dried as quickly as possible, and some drops of origanum oil passed over it. The sections clear in five minutes and then some more origanum oil is applied, or better, some xylol, and these having been displaced, the sections are mounted in resin.

Ehrlich's Hæmatoxylin Solution.*—Prof. P. Ehrlich gives the formula for the hæmatoxylin solution invented by him:—H^2O, 100 c.cm.; absolute alcohol, 100 c.cm.; glycerin, 100 c.cm.; acetic acid, 10 c.cm.; hæmatoxylin, 2 grm.; alum in excess. The mixture is exposed to light until it assumes a deep red colour. The staining power is retained for years. No precipitate ever occurs, provided the vessel is properly corked. If need be, the solution may be employed for double staining.

The author omits to state that sections stained with this preparation should be placed in ordinary (tap) water which is slightly alkaline, not H^2O, in order to bring out the blue colour.

New Staining Method for the Central Nervous System.†—Herr C. Benda hardens small pieces of fresh material in cold saturated picric acid. Hardening is usually completed in two or three days, but longer immersion in the picric acid is not at all harmful. When thus soaked the preparations are hardened again in alcohol. Celloidin appears to have an unfavourable influence on the sections, and paraffin is to be preferred as a saturative medium. Sections, made as thin as possible, are placed for some hours in a solution of an iron salt (the author employed a concentrated solution of iron sulphate), and these after careful and repeated washing in water are transferred to a 1 per cent. watery solution of hæmatoxylin until they become a deep black colour (about 10 minutes). They are next bleached for about five minutes in chromic acid (1 to 2000), washed well in water, dehydrated, and mounted in balsam. This method is stated to give results equal to those of the best carmine and nigrosin stainings; not only are the coarser fibres and their communications with the ganglion cells clearly shown, but the intimate structure of the ganglion cells themselves is made evident.

Action of Methyl-blue on Living Nervous-tissue.‡—Dr. P. Ehrlich has, since his experiments with alizarin blue, investigated the action of methyl-blue on living nervous matter. This staining substance was found to possess an extraordinary affinity for the axis-cylinders, even to the finest ramifications of nerves in the larynx, the eye, and the diaphragm, but not in other parts of the body. Saturation with oxygen and an alkaline reaction of the fibres are the two conditions on which this reaction is dependent.

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 150.
† Arch. f. Anat. u. Physiol. (Physiol. Abth.), 1886, pp. 562–4.
‡ Deutsch. Med. Wochenschr., 1886, No. 4.

Gold Chloride for Sclerosis of Nervous Tissue.*—Dr. A. Wittig, after hardening in Müller's fluid and in alcohol, transfers the spinal cord to a 2 per cent. solution of gold chloride in alcohol of 47 per cent., wherein the preparations remain from six to eight hours, and are afterwards transferred to a 20 per cent. soda solution. After three or four minutes they are removed from this fluid, drained on blotting-paper, and thereupon are immersed in a 10 per cent. solution of iodide of potassium. In this the sections remain 15–30–45 minutes, and are then washed in water. Clearing up is effected by means of bergamot oil or turpentine-creosote and the preparations are mounted in Canada balsam. In this manner were obtained images in no way inferior to those from Weigert's hæmatoxylin. The medullated nerve-fibres appear dark blue on a reddish ground; the ganglion cells, somewhat less darkly stained, showed clearly the nucleus, together with nucleoli, and numerous processes.

Fixing and Staining Flagellata.†—Dr. J. Künstler did not use, in his researches on Flagellata, alcohol and chromic acid, as these fluids gave indifferent results (except in some special cases, e. g. trichocysts). The best reagent is osmic acid in a very concentrated form; weak solutions and the vapour are unsuitable. The author takes 1 grm. of the pure acid and dissolves it in some cubic centimetres of water. The fluid should have a citron-yellow colour. At the bottom of the vessel is usually some undissolved osmic acid. A drop of the fluid containing the Infusoria to be examined is placed on a slide, and then a drop of the osmic acid solution immediately added. The animals are thereby fixed at once. Before staining the acid is allowed to evaporate to prevent over-blackening. A small drop of the staining fluid (the author used methylen green and a concentrated solution of cyanin) is added to the fluid on the slide, a cover-glass imposed, and then closed with paraffin and wax; or the preparation may be left for 24 hours in a moist chamber in contact with a drop of the stain. Then dilute glycerin is added very sparingly, and the preparation closed as before.

The internal protoplasmic substance of the Flagellata is stained and contracted, but the hyaline sheath remains to show the original form of the animal.

Double-staining Botanical Preparations. ‡ — The following method "B.Sc." has found very successful in showing clear differentiation, besides producing slides of great beauty (he is indebted to Prof. Rothrock for the process).

Immerse the section in a *very, very weak* solution of anilin-green for twenty-four hours (at the end of twelve hours the section will most likely have absorbed all the green, in which case add two drops more of the mother solution). Then take a middling strong solution of Beale's carmine, and dip the section in it for from *one* to *five* minutes only; then prepare with alcohol and clove-oil in the usual way, bedding in dammar, lac, or Canada balsam.

* 34 pp., 8vo, Breslau, 1885.

† Journ. de Microgr., x. (1886) pp. 17–25, 58–63 (1 pl.).

‡ Scientif. Enquirer, i. (1886) p. 33.

Double Staining Vegetable Sections.*—It is found that on lifting thin vegetable sections from one fluid to another, so many times as it it is necessary to do in double staining them, they are liable to get broken, and Mr. F. Beddow suggests the following method as a means of avoiding the difficulty:—

After the sections have been cut and the paraffin removed from them, they should be put in specimen tubes (1 in. long and 7/8 in. wide), and a piece of muslin tied over the mouth of each tube. To bleach the sections the tubes are put in chlorinated soda, or in a bottle containing water, through which chlorine is passed. After bleaching, the tubes (still keeping the muslin over the mouths) should be put in a large basin of water, and the water changed several times, then the different stains can be poured into the tubes and poured out again. The sections can be bleached, washed, put in a mordant, stained with carmine, put in an acidulated water to fix the carmine, stained with anilin green, and cleared in benzol or oil of cloves, without once handling them.

Congo Red as a reagent for free acid.†—According to Dr. H. Scholz, Congo red, a dye easily soluble in water, appears to have no action, even in strong solutions, on the lower organisms. It may therefore be employed to demonstrate free acids which occur as the result of the tissue changes of living microscopical organisms. If Rotatoria be examined in the coloured solution they are seen at first unstained in the red-yellow field of view; afterwards, while the investment, tail, and wheel-organs are unstained, the jaws appear a dark rusty red; the stomach walls assume a blue colour, as also, transitorily, the part between the oral cavity and stomach and the upper part of the exit gut. In *Vorticella* and Infusoria reliable results were not obtained. As the blue colour of the acidly reacting parts could not be elicited by transmission of carbonic acid through the solution it was concluded that some other acid was the cause.

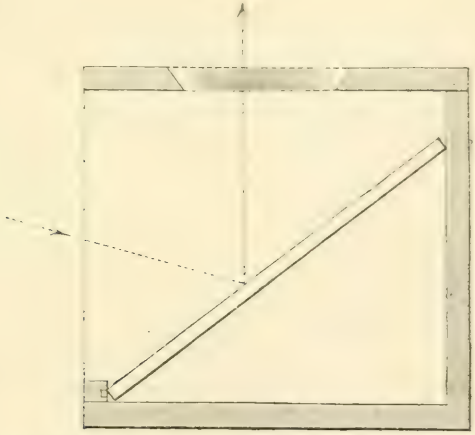
Decoloration of stained Nuclei and Micro-organisms by salt solutions.‡—Dr. A. Gottstein finds that in addition to silver nitrate and potassium bichromate, the decolorizing property is possessed by other salts, such as iodide of potassium, chloride of sodium, the carbonates and sulphates of soda and magnesia, alum, &c. The degree of decoloration depends on the concentration of the salts, and the duration of their action. As well as nuclei, typhoid, pneumonia, gonorrhœa, and putrefaction Bacteria are unstained by these salt solutions. The bacilli of tubercle, lepra, and syphilis are less susceptible than the preceding, and are only deprived of their colour by concentrated solutions. Fuchsin is more sensitive to the decolorizing influence than the violet stains. The reason for the decolorizing action is to be sought in the insolubility of the anilins in the solutions of these salts.

* Sci.-Gossip, 1886, p. 233. † Centralbl. f. d. Med. Wiss., 1886, p. 449.
‡ Fortschr. d. Med., iii. (1885) p. 627.

Obersteiner's Section-finder.*—Prof. H. Obersteiner's instrument (fig. 246) is intended to remove the difficulty often experienced in finding a section which is being stained in a dark-coloured fluid.

The apparatus consists of a simple wooden box about 12 cm. high, 12 cm. broad, and 18 cm. long. One of the long sides, the front, is wanting: in the top of the box is a round hole somewhat smaller than the watchglasses in ordinary use, and cut out in such a way that its upper opening is larger than the lower one. Within the box a quadrangular mirror of about the same length, and of somewhat larger breadth, is placed at an angle of 30° to 40°, so that it looks towards the open side. A small filleting in front serves to keep the

FIG. 246.



mirror in its place. To obtain greater stability, a wood block or any other weight may be fixed within the triangular space behind the mirror.

When used, the apparatus is so placed that the open side faces the window: the watchglass with its contents is placed in the round opening, and by this means sections are easily detected, no matter how dark the staining fluid may be. Under such circumstances much less damage is likely to happen to delicate sections than when fished for in the ordinary way.

Washing Sections.†—Dr. P. G. Unna uses, for washing sections or pieces of tissue, a funnel the spout of which is plugged with cotton wool rammed down tight so that water passes through very slowly. The sections, either alone or tied up in a piece of muslin, are put in the filter and covered over with another layer of cotton wool. Water is then passed through and the filter placed over an empty flask.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 55–7 (1 fig.).
† Monatschr. f. Prakt. Dermatol., v. (1886) No. 3.

The process is improved by means of any apparatus which will supply a continuous current of fluid. It is scarcely necessary to state that other fluids than water may be used for this contrivance.

Histological Technique.*—In "Notes" under this heading, Mr. C. S. Minot makes some very useful and interesting observations, the most important of which refers to the clearing up of celloidin sections.

A mixture of 3 parts of white oil of thyme and 1 part of oil of cloves "clarifies sections very readily and softens the celloidin just enough to prevent the puckering which is so annoying with thyme alone." The author thinks that this process, which is the discovery of Dr. E. K. Dunham, may be improved if the proportions be 4 to 1.

For hardening purposes the author found the use of warmth with Müller's fluid to be inferior to the use of cold. Nitric acid in cases where the specimen is of small size, and especially when it has begun to deteriorate, is said to be very valuable. One part commercial nitric acid (strong) diluted with 9 parts of water, forms the solution in which the specimen is placed for 3 to 5 minutes. It is then transferred to running water for 15 to 20 minutes; 30 per cent. alcohol for 10 minutes; 50 per cent. for 1 hour, and kept in 70 per cent. which is changed daily until it no longer takes on a brownish discoloration due to the acid.

In staining, after giving a formula for a neutral carmine solution, and for an alcoholic eosin solution, with a note on Weigert's hæmatoxylin, the author recommends a picrocarmine made by boiling 1 grm. powdered carmine, with 200 c.cm. of water plus an excess of picric acid for half an hour; allow to stand and cool; decant the clear fluid, add fresh water, and if necessary picric acid, boil, cool and decant, repeat this operation until all the carmine is dissolved. Place the decanted fluid in an evaporating dish, add about 1 grm. thyme oil and stand in a warm place until the volume is reduced to 25 c.cm., let the solution cool, filter, wash out the residue which should be on the filter with 25 c.cm. water, dilute the filtrate with 50 c.cm. water. The solution keeps indefinitely, and gives a stronger differential colouring of the tissues than Ranvier's picrocarmine, but the contrast between the nucleus and the protoplasm is less. "It is, however, made equal and equivalent to the latter (Ranvier's) by adding very dilute ammonia to the picric acid solution until it *begins* to assume a rich wine-red shade which is quite distinct from that of the acid solution."

The article also contain notes (1) on alcohol, in which it is stated that absolute alcohol is an unnecessary extravagance, 96 per cent. being entirely sufficient for all manipulations; (2) on benzole which can be used to replace the much dearer xylol, and (3) on imbedding in celloidin (cf. *ante*, p. 164).

Eau de Javelle.†—Dr. J. H. List, on making serial sections of *Orthezia cataphracta* West., experienced unusual difficulties owing to the brittleness and inequalities of the chitinous investment. To

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 173-8. † Ibid., p. 212.

partially remedy this he tried Eau de Javelle diluted with four times its volume of water. The animals, hardened in Frenzel's or in List's sublimate and picric acid mixtures or in 90 per cent. alcohol, were left in the fluid for 18 to 24 hours. After being well washed they were gradually hardened in alcohol and then imbedded in paraffin.

Thus diluted Eau de Javelle permits good staining (alum carmine and picrocarmine) even though five or six days may be required. Secondly, the chitin loses its great brittleness, and good sections are obtained. Thirdly, no alteration of the delicate structures was observable. In order to render the animals transparent for examination of the parts about the gullet, the author boiled them in the undiluted fluid, but prefers a 10 per cent. potash solution on account of its more speedy action.

Eau de Javelle as a test for very minute Starch particles.*—Dr. E. Heinricher, in commenting on the resisting power of starch to Eau de Javelle, remarks that after acting for four days on the leaves of *Argemone grandiflora* no starch granules were to be found in the cells but that the iodine reaction gave evidence of a starchy paste therein. So, too, leaves of *Crambe cordifolia* showed starch after 24 hours' immersion in Eau de Javelle though all the rest of the cell-constituents were destroyed. If, however, a glass stoppered bottle instead of open vessels be used and put in a dark place, the action ensues more quickly. Hence from destroying the plasmatic substances and the relatively late solution of the starch Eau de Javelle may be considered suitable for the demonstration of the smallest quantities of starch, and the author finds this test, when combined with iodine, to be more sensitive than that recently advocated by Schimper who advised a combination of chloral and iodine.

Resins used for Microscopical Purposes.†—1. *Shellac.*—Dr. O. N. Witt remarks that the conflicting views on the value of shellac are due probably to impurities, although the purest shellac is a complex mixture of different substances, and he endeavours to show that only a part of these constituents possess properties useful to the microscopist.

There are two varieties of shellac, the raw or unbleached, and the bleached. The latter is obtained by removing the colouring matter from the former variety by means of Eau de Javelle and hydrochloric acid. Apart from the colouring matter the two kinds are alike, being composed of three constituents, wax, resin, and a body chemically allied to fat, being the glyceride of an acid, for on dry distillation it produces acrolein. It is the resin, however, which gives shellac its microscopical value, and this the auther obtained by first removing the wax by acting on powdered bleached shellac with petroleum-benzin in the cold. When some of the solution, allowed to evaporate in a watchglass, does not leave a residue of wax the treatment is suspended. The powder, spread on filter-paper, is dried in the air, and the resin obtained therefrom by dissolving it in a *large* quantity of alcohol.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 213–5. † Ibid., pp. 196–206.

The further treatment of the resinous solution varies with the intended application. If a very pure resin be desired it is advisable to let the solution stand in a cool place for weeks, in order to allow any fatty matter to separate out. The solution is then filtered and concentrated by distillation. If only required as a sealing varnish, concentration may be proceeded with at once. According to the author, the resin thus obtained possesses every quality desirable in a mounting or inclosing medium; in toughness, hardness, and permanency it is unequalled, and while quite colourless and transparent, easily takes up anilin dyes of any desired colour.

When used for mounting the shellac resin is dissolved in isobutyric-alcohol, as ordinary spirit is found in practice to be too hygroscopic.

2. *Storax.*—Fluid storax as it occurs in commerce is a thick, viscid opaque mass, with an agreeable smell and a mouse-grey colour. The opacity is due to numerous drops of water and solid impurities which are removed by dissolving the balsam in three or four times its weight of ether, and leaving the solution in contact with calcium chloride for some days. By filtration and distillation over a water-bath pure fluid storax is obtained. The following bodies are found therein:—(1) styrol; (2) cinnamic acid; (3) ethyl-vanillin; (4) styracin; (5) cinnamic methylate; (6) cinnamic ethyl-propylate; (7) two bodies of unknown constitution, α and β storesin; (8) a resin. The last five bodies may be considered the actual constituents, as the first three only appear in very small quantities, and after being kept for a long time, constituents 5 and 6 disappear; but this disappearance is unaccompanied by any diminution in volume or weight. The reason of this the author afterwards explains. In order to separate the fluid from the solid constituents, the storax is treated with petroleum-ether (boiling point 45°–50° C.). The solid residuum is placed in glass bulbs, and petroleum-benzin poured over. After being well shaken up it is allowed to stand until the solution separates into two layers, when the colourless solution is poured off. This treatment is repeated thrice, and then by distilling off the petroleum-benzin, a colourless oil of a high refractive index is obtained.

When dry the resin becomes quite hard, but is still brown, and to deprive it of this colour it is treated with about five times its weight of pure benzol, and then petroleum-benzin added slowly until the fluid becomes the colour of hock. Having settled, it is filtered, and the solvent distilled off from the filtrate. As an imbedding medium the resulting substance is faultless. Its refractive coefficient is that given by Van Heurck. It is of a dark yellow colour in bulk, but colourless in thin layers. When cold it is perfectly solid, and although its melting-point is lower than that of Canada balsam, it is quite brittle when exposed to the hottest sun.

This medium, for which the name of styresin is proposed, is dissolved for use in turpentine oil and treated exactly like Canada balsam.

The cause of the spontaneous hardening of storax after standing for many years, is associated with the presence of the pure cinnamic

ethylate. This body can also be prepared synthetically by treating a solution of cinnamic acid in ethylic alcohol with hydrochloric acid gas. After standing for months this fluid, at first as clear as water, begins to grow cloudy from the presence of amorphous particles, which by their increase, render the fluid quite thick in the course of years. This appearance is due to polymerism, a condition to which all the derivatives of cinnamic acid are liable. Consequently, after long standing, the quantity of the solid constituents of storax increases at the expense of the fluid.

Carbolated Glycerin-gelatin.*—Señor Lázaro é Ibiza, who has been experimenting with carbolated glycerin-gelatin as a substitute for Canada balsam, remarks that gelatin being much more soluble hot than cold, it is possible to obtain solutions which, saturated at 50°, 60°, 70°, or higher, are solid at the ordinary temperature of museums and laboratories. A piece of this gelatin, slightly warmed on a slide, melts and allows the object to become immersed in it, and after putting on a cover-glass, the gelatin solution solidifies, thus keeping the object in position and firmly fixing the two glasses.

The use of this substance offers two advantages. (1) The point of concentration of the substance is obtained on preparing the solution. (2) Cleaning the preparation is effected by merely washing the edges with a brush and water. The author uses Kaiser's formula:† gelatin 1 part; water 6 parts; glycerin 7 parts. The gelatin is macerated in water for two hours; the glycerin is then added and also pure carbolic acid, in the proportion of 0·01 of the mixture. It is then boiled for ten minutes and filtered while warm.

Apart from its general advantages, carbolated glycerin-gelatin may be recommended for those substances which are dry or but little juicy. The author has found it excellent for the preservation of diatoms, pollen, epidermis, and wood-sections. Moreover, it offers great facilities when preparations are only required for a few days or months, as the slides are easily cleaned by merely washing in water. If the preparation is to be kept indefinitely the edge of the cover-glass should be cemented down, for if not, the gelatin becomes slightly coloured, probably from the volatilization of the antiseptic, and hence the author suggests the substitution of salicylic acid. It is not advisable to use this gelatin mixture for mounting soft objects, the juices of which are easily alterable.

The possibility of obtaining preservative media which are liquefiable at very low temperatures (30·5°) affords the opportunity of preserving algæ and delicate fungi which are unable to resist the disorganizing action required for mounting objects in balsam.

Mounting in Glycerin-jelly.‡—Mr. W. T. Suffolk, a member of the committee appointed to examine the cabinet of the Society, found that whilst in all cases slides properly mounted in balsam were unaltered, the objects mounted in glycerin-jelly had been affected by

* Anal. Soc. Española Hist. Nat., xiv. (1885), Actas, pp. 12–5.

† See this Journal, iii. (1880) p. 502.

‡ 15th Ann. Rep. South London Micr. and Nat. Hist. Club, 1886, p. 13.

shrinkage. If care, however, is exercised, satisfactory results can be obtained with glycerin-jelly. The object should be first soaked in diluted glycerin, and properly deposited in its cell. After the cover is put on, a ring of balsam and benzole should be applied and allowed to harden; the slide is then to be well washed under the tap, and a ring of shellac varnish added. Another washing and another coating of shellac follows, and then the object is to be more permanently varnished with successive coats of gold size laid on as thinly as possible. Slides so prepared will last upwards of 25 years.

Needle for manipulating objects immersed in Canada Balsam.—Mr. J. Joly (B.E. Trinity College, Dublin) writes:—The accompanying sketch (fig. 247) depicts an easily made contrivance, which has been of much service to me in arranging minute crystals in Canada balsam. A warm needle is essential for this kind of work

Fig. 247.

unless the balsam be rendered very thin with a solvent, but the latter plan is inconvenient with lumpy objects, which will soon be left protruding by the very thin balsam, and the addition of more balsam subsequently is very likely to disturb the arranged objects. I found it necessary to work in thick balsam, keeping the needle hot by inserting it frequently in a spirit flame, taking care to withdraw it from the balsam before it had fallen to the solidifying or *thickening* point of the balsam. This was an arduous way of proceeding, and led me to devise a needle which would stay hot without any attention from the manipulator, and the temperature of which would be adjustable.

To this end the needle is so mounted that the current from a small bichromate cell may be passed through a portion of its length, the point becoming warm by conducting heat from the portion traversed by the current. The arrangement will, I hope, be understood from the figure. A wooden or ivory pen-handle is drilled axially to receive a brass wire, one end of which is connected with one of the binding screws affixed at the end of the handle, the other end is split to receive the head of the needle at *d* in the figure. A barrel, with a spring forceps, clips the needle at *c*; this barrel is electrically connected with the second binding screw on the handle by a fine copper wire *a b* let into the handle along its whole length. A current entering at one binding screw traverses the length *c d* of the needle and leaves by the second binding screw.

I find that with this arrangement a needle one-half larger than that figured may be kept sufficiently hot when the plates of a one pint bichromate cell are about one-half immersed; the temperature is adjustable to a nicety by letting down the plates more or less. Very fine spirally coiled wires do for connections and do not interfere with

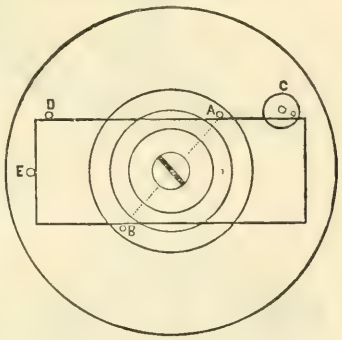
freedom of manipulation. Work may be carried on rapidly, the balsam yielding at once to the sustained temperature of the needle, which moves freely through it, and imparting its heat to the tiny crystals enables them to be turned and examined with much ease.

Griffith Turntables.*—Mr. E. H. Griffith describes two more of his turntables.

The first was described Vol. IV. (1884) p. 826, but has now been improved, and as improved is thus described by Mr. Griffith (figs. 248 and 249):—

The centre of the table, marked with the circles, has a straight spring attached to it beneath. The slide being placed between the two pins A and B in this centre, is partially rotated against the spring and pushed forward, when the spring keys it between the two pins and a third fixed pin D at the upper side of the slide, centering it perfectly for width. The fourth pin E at the left end, 1½ in. from the centre, is for length, and allows the slide to be always placed in the same relative position. The recent improvements add much to the value of the table. One of them is a countersunk decentering wheel and pin C, which may be seen at the upper right-hand side of the slide. The axle of the wheel passes through the table and is furnished underneath with a short bar with which the decentering wheel may be turned, forcing the pin against the slide, pushing it as far out of centre as may be desired. Another improvement is in making the end-pin a screw, which may be turned down out of the way if desired.

Fig. 248.



The second (fig. 250) presents the peculiarity that the spindle is hollow, for illuminating the centre of the slide for mounting purposes.

The table has two grooves A and B, milled across the upper surface, equidistant from the centre F and tending towards a common point beyond. To these grooves are fitted two followers, and to the followers are fastened two thin narrow brass plates C and D, parallel to each other, and which are the slide-holders. The pin E is a small screw, which may be turned back out of the way or used as an end-pin, it being 1½ in. from the centre of the table. The slide may be placed between the two plates C and D and made to abut against the end-pin E. Then if C and D are pushed the same distance in the direction of E they will clamp the slide firmly and centre it perfectly for width. If it be desired to decentre the slide, one of the plates must be pushed farther than the other.

Some years ago General William Humphrey, of Jackson, Mich.,

* Proc. Amer. Soc. Micr., 8th Ann. Meeting, 1885, pp. 112-3 (2 figs.).

an expert preparer of slides, suggested that an arrangement for illuminating the centre of slides would be of great convenience, and the hollow spindle in this turn-table is the result of the suggested

Fig. 249.

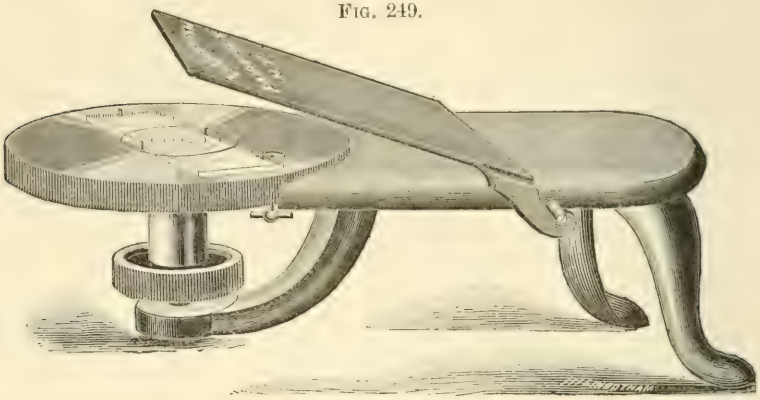
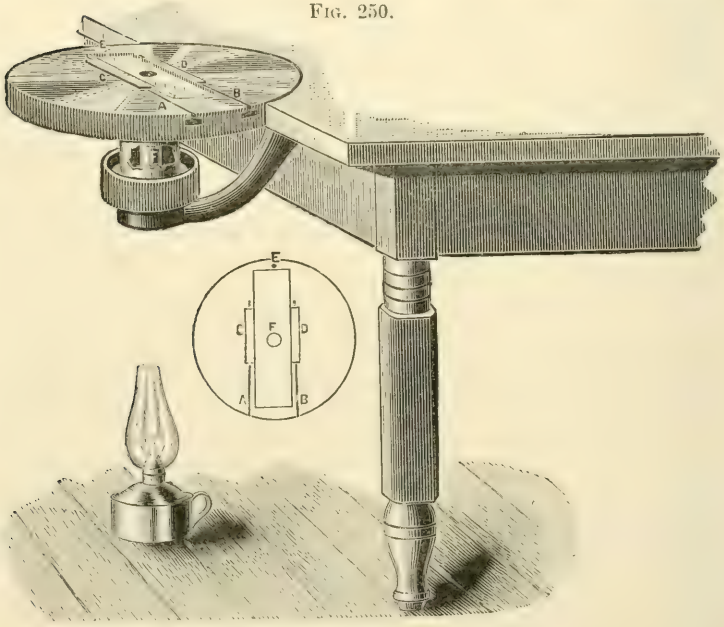


Fig. 250.



need. A small mirror may be placed underneath and the light be reflected through the spindle, or a lamp may be used for the same purpose.

Afanassiew, M.—**Gram's Method of Staining applied to the Examination of the Micro-organisms in Pneumonic and Tuberculous Sputum.**
Edinburgh Med. Journ., 1885, pp. 717–26 (1 pl.).

Beddow, F.—**Staining Vegetable Sections.** [*Supra*, p. 1092.]
Sci.-Gossip, 1886, p. 233.

Bergeaud.—See *Crookshank, E. M.*

Bienstock, B.—**Zur Frage der sog. Syphilis-bacillen und der Tuberkel-bacillen-färbung.** (On the so-called Syphilis Bacilli and Tubercle Bacilli Staining.) [*Post.*]
Fortschr. d. Med., IV. (1886) p. 193.

Blochmann, F. — **Die Mikroskopische Thierwelt des Süsswassers.** (The Microscopical Fresh-water Animal World.)
[Part II. of 'The Microscopical Fresh-water Vegetable and Animal World.']
iv. and 122 pp., 7 pls., 4to, Braunschweig, 1886.

Breckenfeld, A. H.—**[Gold-plated Diatoms.]**
[Exhibition.] *Proc. San Francisco Micr. Soc.*, Sept. 1886.
Cf. *Engl. Mech.*, XLIV. (1886) p. 170.

Chrustschoff, K. v.—**Mikropetrographische Mittheilungen.** (Micropetrographic Communications.)
Tschermak's Mineral. u. Petrogr. Mittheil., VII. (1886) p. 295.

Cole, A. C.—**Studies in Microscopical Science.** Vol. IV. Sects. I.–IV. Nos. 3 and 4 (each 4 pp.).
Sect. I. Botanical Histology. No. 3. A bifacial leaf. Plate III. Leaf of Ivy (*Hedera helix*). Vert. Sect.—No. 4. Absorbent Organs. Plate IV. *Salvinia*, *Lepidium*, and *Ulva*.
Sect. II. Animal Histology. No. 3. The Human Penis. Plate III. Penis of Infant, at term × 11.—No. 4. The Penis in the lower Animals. Plate IV. Penis of Dog. Trans. Section × 14.
Sect. III. Pathological Histology. Nos. 3 and 4. Normal Kidney (*contd.*) Plate III. Acute Congestion of Kidney. [Plate IV. ?]
Sect. IV. Popular Microscopical Studies. Nos. 3 and 4. The Sea Fans (*contd.*). Plate III. Spines and Plate of *Palmipes membranaceus*. Plate IV. Marine Alga, *Ptilota elegans*.

Crookshank, E. M.—**Manuel pratique de Bactériologie basée sur les méthodes de Koch.** (Practical Manual of Bacteriology based on the methods of Koch.) *Transl.* by *Bergeaud.*
300 pp., 32 pls., and 44 figs., 8vo, Paris, 1886.

Esmarch, E.—**Ueber eine Modification des Koch'schen Plattenverfahrens zur Isolirung und zum quantitativem Nachweis von Mikroorganismen.** (On a modification of Koch's plate process for the isolation and quantitative analysis of Micro-organisms.) *Zeitschr. f. Hygeine*, I. (1886) p. 293.

Friedländer, C.—**Ueber die färberische Reaction der Tuberkelbacillen.** (On the colour reaction of Tubercle Bacilli.)
Fortschr. d. Med., VII. (1886) p. 196.

Gabel, H. G—**Investigation with the Microscope.**
["An interesting and instructive paper, in which he calls the attention of the profession to the great service which the Microscope is rendering in the field of medicine. He also offers several pleasant bits of advice and practical suggestions."]
The Microscope, VI. (1886) pp. 208–9, from *Chicago Med. Times.*

Garbini, A.—**Manuale per la Tecnica moderna del Microscopio nelle osservazioni istologiche ed anatomiche.** (Manual of the modern technique of the Microscope in histological and anatomical observations.)
2nd ed., 400 pp. and 94 figs., 8vo, Verona, 1886.

Giacomini, C.—**Nuovo processo di Conservazione delle Sezioni microscopiche.** (New process for preserving microscopical sections.) [*Post.*]
Giorn. R. Accad. Medic. Torino, 1885, Fasc. 10–12, 28 pp.

Gottstein, A.—**Die Beeinflussung des Färbungsverhaltens von Mikro-organismen durch Fette.** (Relation of fatty matter to the receptivity of staining in micro-organisms.) [*Post.*] *Fortschr. d. Med.*, IV. (1886) p. 252.

Guarneri, A.—**Nota di tecnica micologica.** (Note on mycological technique.)
8vo, Milano, 1886.

HASWELL, W. A.—**Cutting Sections of delicate Vegetable Structures.** [*Post.*]
Journ. Linn. Soc. N. S. Wales, I. (1886) p. 489.

[HITCHCOCK, R.]—**[Shellac Cement.]**
[Defence of shellac cement, which is "the only cement that has come into our hands (and we have tried many) that never fails."
"There is another reason why we have so persistently urged its use in these columns, until we doubt not many of our readers are tired of it, and are inclined to regard us as a crank on the subject. The reason is that so many of the best observers and students do not mount specimens for preservation because they have not the time to spare. There is just reason for this if the ordinary methods of mounting in fluids are followed, while Canada balsam is not the proper medium. But by using shellac, a permanent mount, dry, in water, or in glycerin, can be made on a plain slide in five minutes, and it will keep perfect for years."]
Amer. Mon. Micr. Journ., VII. (1886) p. 177.

HOCHSINGER, C.—See Kassowitz, M.

HOYER, H.—**O mikroskopowem badaniu grzybkow.** (On the microscopical investigation of pathogenic Fungi.)
[Describes the methods used by the author.]
Gazeta Lekarska, IV. (1884) pp. 67–72, 87–96, 107–15.

JAMES, F. L.—**Elementary Microscopical Technology.**
[IX. Preparation of the slip. Cements. X. The cell-wall.]
St. Louis Med. and Surg. Journ., LI. (1886) pp. 34–42, 98–103 (2 figs.).

KASSOWITZ, M., and HOCHSINGER, C.—**Ueber einen Mikroorganismus in den Geweben hereditär-syphilitischer Kinder.** (On a Micro-organism in the tissues of hereditarily syphilitic children.)
[Methods, *post.*] *Wiener Med. Blätter*, 1886, Nos. 1–3.

KRÖNIG.—**Einschlusskitt für mikroskopische Präparate.** (Cement for microscopical preparations.) [*Post.*]
Arch. f. Mikr. Anat., XXVII. (1886) pp. 657–8.

LATHAM, V. A.—**The Microscope, and how to use it. VIII.**
[B. Agents which harden and at the same time colour the tissues.]
Journ. of Microscopy, V. (1886) pp. 230–8.

MACFARLANE, J. M.—**On a new method of preparing the epidermal Tissues of Pitcher-plants.** [*Post.*]
Report 55th Meeting Brit. Assoc. Adv. Sci., 1885 (1886) p. 1088.

MACMUNN, C. A.—**Note on a method of obtaining Uric Acid crystals from the Malpighian tubes of Insects and from the nephridium of pulmonate Mollusca.** [*Post.*] *Journ. of Physiol.*, VII. (1886) pp. 128–9.

MARK, E. L.—**Some Laboratory Appliances.**
[1. Water-bath apparatus for paraffin. 2. Orienting larger objects in paraffin. 3. Dissecting pans. *Post.*]
Amer. Natural., XX. (1886) pp. 910–5 (3 figs.).

Medland's (J. B.) new Portable Cabinet. [*Post.*]
Sci.-Gossip, 1886, p. 258 (1 fig.).

MILLER, M. N.—**A new Imbedding process for microscopic work.** [*Post.*]
New York Med. Record, XXVII. (1885) p. 429.

MIURA, M.—**Beiträge zur Kenntniss der Gallencapillaren.** (Contribution to the knowledge of the gall capillaries.) [*Post.*]
Virchow's Arch. f. Pathol. Anat. u. Physiol., XCIX. (1885) pp. 512–21 (1 pl.).

MOLISCH, H.—**Ein neues Coniferinreagens.** (A new reagent for Coniferin.)
[*Post.*] *Ber. Deutsch. Bot. Gesell.*, IV. (1886) pp. 301–5.

„ „ **Eine neue Methode zur Unterscheidung der Pflanzen- von den Thierfaser.** (A new method of distinguishing vegetable from animal fibres.)
[*Post.*] *Dingler's Polytechnisches Journal*, CCLXI. (1886) p. 135.

„ „ **Zwei neue Zuckerreactionen.** (Two new sugar reactions.)
[*Post.*] *SB. K. Akad. Wiss. Wien*, 1886, pp. 912–23.

MYA, G.—**Il nitroprussiato di sodio quale reagente di sostanze albuminose.** (Sodium nitro-prussiate as a reagent for albuminous substances.)
Gazz. delle Clin., XXIII. (1886) p. 186.

NEVILLE, J. W.—**Wilks' Cell.**
[Remarks on using it. Suggestion that it should have at least twice the number of elevations or, perhaps better still, be corrugated.]
Sci.-Gossip, 1886, p. 233.

PFEFFER, W.—**Vorläufige Mittheilungen über Stoffaufnahme.** (Preliminary notes on absorption.)
[Methods, *post.*] *Bot. Ztg.*, XLIV. (1886).

Pfeifer's (A.) Revolving Automatic Microtome. [*Post.*]
Stud. Biol. Laborat. Johns Hopkins Univ., III. (1886) pp. 477–9 (1 fig.).

PRIMAVERA, G.—**Atlante di Microscopia Clinica.** (Atlantis of Clinical Microscopy.) pp., 68 pls., fol., Napoli, 1886.

PRUDDEN, T. M.—**On Koch's methods of studying the Bacteria, with special reference to the Bacteria causing Asiatic Cholera.**
Rep. Connect. State Board of Health, 1885, 18 pp.

REYNOLDS, R. N.—**Staining Human Spermatozoa.**
The Microscope, VI. (1886) pp. 196–7.

ROUX, G.—**Sur un procédé technique de diagnose des Gonocoeci.** (On a technical method for diagnosing Gonococci.) [*Post.*]
Comptes Rendus, CIII. (1886) pp. 899–900.

RUDLER, F. W.—**On the application of the Microscope to the Study of Rocks.**
Proc. and Trans. Croydon Micr. and Nat. Hist. Club, 1886, pp. 13–6.

RUTHERFORD, W.—**A combined Ice and Ether-spray Freezing Microtome.**
[*Post.*] *Lancet*, I. (1885) pp. 4–6.

SCHOLZ, H.—**Ueber das Congoroth als Reagens auf freie Säure.** (On Congo-red as a reagent for free acid.) [*Post.*] *Centralbl. f. d. Med. Wiss.*, 1886, p. 449.

SLACK, H. J.—**Pleasant Hours with the Microscope.**
[Ferments.] *Knowledge*, IX. (1886) pp. 349–50 (9 figs.).

SMITH, A. P.—**Notes on the identification of Alkaloids and other Crystalline Bodies by the aid of the Microscope.** [*Post.*]
Journ. of Microscopy, V. (1886) pp. 210–8 (2 pls.), from the *Analyst*.

SUFFOLK, W. T.—**Glycerin-jelly Mounts.** [*Supra*, p. 1097.]
15th Ann. Rep. South Lond. Micr. and Nat. Hist. Club, 1886, p. 13.

TAYLOR, T.—**Butter and Fats and Oleomargarine.**
[Abstract of his reply to Prof. Weber.]
Amer. Mon. Micr. Journ., VII. (1886) pp. 169–70 and 162.

TRICOMI.—**Nuovo Microtomo a mano.** (New hand Microtome.)
[The preparation is raised by a screw, and there is an arrangement for fixing the object without imbedding in paraffin or other substances.]
Rivista Internaz. Med. e Chir., 1886, p. 279.

UNNA, P. G.—**Zur Histotechnik.** (On histo-technique.) [*Post.*]
Monatschr. f. Prakt. Dermatol., V. (1886) No. 3.

„ „ **Eine neue Darstellungs-methode des elastischen Gewebes der Haut.** (A new method of demonstrating the elastic tissue of the skin.)
[*Supra*, p. 1071.] *Ibid.*, No. 6.

VRIES, H. DE—**Een Middel tegen het bruin worden van Plantendeelen bij het Vervaardigen van Praeparaten op Spiritus.** (A method of preventing the browning of plant preparations.) [*Supra*, p. 1075.]
Maandblad v. Natuurwet., 1886, No. 1, 7 pp.

WHITELEGGE, T.—**List of the Fresh-water Rhizopoda of N. S. Wales. I.**
[Directions for collecting and mounting. *Post.*]
Journ. Linn. Soc. N. S. Wales, I. (1886) pp. 497–504.

WOODWARD, A. L.—**On Cell Cements and Finishes.**
[Note as to his practical experience in the use of shellac varnish and gold-size and lampblack.]
Scientif. Enquirer, I. (1886) pp. 188–9.

PROCEEDINGS OF THE SOCIETY.

Meeting of 13th October, 1886, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 9th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Brevoort, H. L., Fur Fibres as shown by the Microscope. 5 pp. and 16 pls. (4to, New York, 1886)	*The Author.*
Curnock, N., Nature Musings on Holydays and Holidays; with an introduction by Rev. W. H. Dallinger, LL.D., F.R.S. xvi. and 232 pp. and 1 pl. (8vo, London, 1886)	*The Publishers.*
Etheridge, R., jun., and P. H. Carpenter, D.Sc., F.R.S., Catalogue of the Blastoidea in the Geol. Depart. British Museum. (Nat. Hist.). xv. and 322 pp. and 20 pls. and 7 figs. (4to, London, 1886)	*The Trustees of the British Museum.*
Francotte, P., Manuel de Technique Microscopique applicable à l'Histologie, l'Anatomie Comparée, l'Embryologie et la Botanique. vii. and 433 pp. and 110 figs. (8vo, Bruxelles, 1886)	*The Author.*
Friedländer, C., Microscopische Technik zum Gebrauch bei medicinischen und pathologisch-anatomischen Untersuchungen. vii. and 132 pp. (8vo, Cassel and Berlin)	*Mr. Crisp.*
Hudson, C. T., and P. H. Gosse, The Rotifera or Wheel-Animalcules, Part V., pp. 49-96, pls. 21-5. (8vo, London, 1886)	*The Publishers.*
Jennings, J. H., Photo-micrography; or, how to Photograph Microscopic Objects; also a chapter on preparing Bacteria, by Dr. R. L. Maddox. viii. and 128 pp. and 30 figs. (8vo, London, 1886)	"
66 Specifications of Patents relating to Optical Instruments ..	*The Patent Office.*
12 Slides of Fossil Entomostraca	*Mr. Crisp.*

Letters were read from Prof. H. de Lacaze-Duthiers and Prof. W. A. Rogers in acknowledgment of their election as Honorary Fellows of the Society.

The President said that it fell to him to take notice of the fact that Mr. George Busk, F.R.S., an Honorary Fellow of the Society, had died since the date of their last meeting. He had been intimately associated with their Society, having been its President in 1848 and 1849, and although he (Dr. Dallinger) never had the pleasure of a personal acquaintanceship with him, the name of Mr. Busk had been before him from the time of his very earliest studies. Every one was familiar with his labours in connection with the Polyzoa, and he felt sure that all present would regret to receive the intimation of his decease. An excellent portrait in oil of Mr. Busk, painted by his

daughter, had recently been presented to the Linnean Society, while an appreciative memoir has been published * by his friend Prof. Allman.

Mr. Curties exhibited several of the new apochromatic objectives (with a series of eye-pieces) made of the new kinds of glass from the Jena manufactory, which were examined by the Fellows with great interest; the very high eye-pieces which they carried without "breaking down" being a special subject of comment.

Prof. Abbe's paper "On Improvements of the Microscope with the aid of new kinds of Optical Glass," was read (*post*).

The President said he had been greatly interested by the explanations given in Prof. Abbe's paper, and the Fellows would doubtless be glad to know that the 1/12 in. objective was in the room that evening, and fitted to a Microscope with a suitable eye-piece, so that its perfection could be seen by those present.

Mr. Cheshire inquired whether the new kinds of glass could be bought in this country, and if full particulars could be obtained as to their respective indices, dispersive powers, &c., so as to make it possible for similar objectives to be made here in due course by English opticians, suitable for their own instruments? The objectives shown that evening gave results which he could only describe as most magnificent.

Mr. Crisp said that a very full and complete descriptive catalogue had been published, in which all particulars were given as to the optical qualities of the glass. Indications were given as to the best kinds to be used in the construction of objectives for telescopes, &c., but with regard to Microscope objectives, the subject was dismissed with the remark, that "it must be left to the skill of the practical optician to choose the most suitable from the above series. The new objectives show what can be attained in practice." It was of course quite fair to keep such a matter as a trade secret, and it could not be expected that opticians should publish their trade methods and formulæ for the benefit of their business competitors.

Mr. T. B. Rosseter's paper "On *Trichodina* as an Endoparasite," was read by Prof. Bell. The author described a very careful series of observations, by which he had established that this Infusorian hitherto only known as an Ectoparasite, infested the urino-seminiferous organs of newts (*supra*, p. 929).

Dr. Crookshank said it would perhaps be remembered that during the last Session he read before the Society a paper on Photomicrography (*ante*, p. 735), in illustration of which he then showed a number of photographs of bacteria. He had done some further work in that direction, and had brought with him a new negative which he was anxious the Fellows should examine, because it was one in which the flagella of a *Vibrio* were very distinctly shown. It would, no doubt, be known to most of the Fellows that some persons had

* Nature, xxxiv. (1886) pp. 387-9.

doubted the existence of a flagellum, but although it was a thing very difficult to be seen, this was not the first time it had been photographed. Koch had been able to do this after a process of staining, for which he recommended the use of a watery solution of logwood and subsequent treatment with chromic acid, but he had rather given up the attempt to photograph specimens unless he could get them stained brown. This, however, he (Dr. Crookshank) had not found to be essential when using isochromatic plates; the specimen shown had been stained with gentian violet, and it would be found on examination that the flagella were very distinctly seen. He would also hand round for inspection another negative, to show that it was possible to get very good results without staining brown; the specimen being *Spirochæta*, from sewage-contaminated water, for which he was indebted to Mr. Cheshire. He had also mentioned in the paper to which he referred that in reproducing the photographs the colour given to the prints was rather objectionable, and he had suggested to the Autotype Company that they should try to use some other colouring matter for the purpose, but it had been found very difficult to carry out this idea at present. The micro-organisms exhibited had been enlarged 25,000 times.

The President said that to him it was of exceeding interest to examine the photographs which had been brought for their inspection by Dr. Crookshank, seeing that they depicted objects which for years he had been drawing and studying. Koch had for a long time failed to detect the flagella with his eye, but when he photographed the object the flagella appeared. Now that they were able to obtain photographs in the manner which Dr. Crookshank had so successfully adopted they would be able to see for themselves all the minute details which had been described. He felt it was a great gain to have photo-micrography so readily and easily at disposal, and personally he felt very much obliged to Dr. Crookshank for bringing the matter before them.

Mr. Crisp inquired if Dr. Crookshank had tried to obtain photographs by means of the new objectives. One of the greatest advantages claimed for them was their use in photo-micrography, apart from the advantage of being able to obtain the same power with an 1/8 in. objective as had been obtained with the very much higher powers used in producing the negatives exhibited.

Dr. Crookshank said he had not yet had any opportunity of trying either the objectives or the projection eye-pieces. His negatives were taken with a 1/25 in., by Powell and Lealand.

Mr. C. D. Sherborn and Mr. F. Chapman's paper "On some Microzoa from the London Clay, exposed in the Drainage Works, Piccadilly, in 1885," was taken as read, as it had been printed during the recess (*ante*, p. 737).

Dr. Anthony's note on the observation of opaque or quasi-opaque objects in the Microscope, was also taken as read, having been printed during the recess (*ante*, p. 857).

Prof. F. Jeffrey Bell said that the subject of grouse disease was always more or less attractive to those who were interested in these birds, but yet nobody seemed to know with any certainty what it really was. A short time ago two grouse which had been found dead on one of the moors were sent up to him, and he had made an examination of them, with the idea of ascertaining if there were any appearances in their organs which would throw any light upon the subject. There were, of course, any number of theories to account for the disease, and it had been often said that it was due to the presence of animal parasites in the liver. Another opinion was that it was caused by a worm (*Strongylus*) which was found by Dr. Cobbold, and was considered by him to have been the undoubted source. It was also said to be caused by a species of tapeworm (*Tænia*). He had, therefore, carefully examined the two grouse in question, but found all their organs healthy, with no sign of any disease likely to account for their death. Nothing of the nature of *Coccidia* could be discovered in the liver, and though he carefully examined the large cæca he failed altogether to find Dr. Cobbold's parasite; but he found that about six inches of the intestine was occupied by *Tænia calva*. This appeared at first to be of some importance, because when the large size of this tapeworm was considered, it was easy to suppose that a considerable stoppage might be caused by it. One of the grouse had two tapeworms, and the other had three. The former of these had its fæces quite healthy, the latter had them more watery; but so far as appearances were concerned he came to the opinion that if the grouse were otherwise healthy and well nourished, probably the tapeworms were not doing very much harm; and whilst the grouse with the two tapeworms was in rather an emaciated condition, the one with three was in good condition and apparently perfectly healthy. He therefore came to the conclusion that the tapeworms were neither the immediate nor the remote cause of the death of the two grouse, and that they neither died from Dr. Cobbold's declared cause, nor from the presence of *Coccidia* in the liver. He was inclined to the opinion—which he believed was held by many sportsmen and gamekeepers—that the disease was due to some condition of the heather, or whatever else the birds fed upon, rather than to the attacks of animal parasites.

Mr. J. Joly's note on a needle for manipulating objects in Canada balsam was read by Mr. Crisp (*supra*, p. 1098).

Prof. F. Jeffrey Bell said that during the present year he had been interested in a worm, the origin of which was undoubtedly exotic. It appeared to have been first noticed here in 1878, in the Palm-house at Kew, from which circumstance it had received the name of *Bipalium kewense*. Subsequently it was found at Welbeck, and since then at the Zoological Gardens and other places which were in direct relation with Kew. More recently he had received it from various correspondents, some of whom were not in relation with Kew, but all were agreed that it had come to them in connection with orchids, and

there seemed to be a general opinion that it had come from Burma. Prof. Moseley, however, thought it had come from Japan. A remarkable circumstance in connection with it was that no specimen had yet been found with generative organs, although it was quite certain that the species multiplied with rapidity. It was therefore a matter of wonder how such an increase could under these conditions be accounted for, and the suggestion was made that it might possibly be by transverse fission, a process which had been the subject of some controversy. Sir J. G. Dalyell and others asserted that Planarians divided transversely, whilst, on the other hand, Schultze stated that he had seen large numbers and kept them under observation, but had never seen any indication of transverse fission. It was further stated that this mode of reproduction only occurred in the case of those with straight intestines; but in 1883, Von Kennel, and more lately Zacharias, had seen transverse fission take place in Planarians with branched intestines; and whilst he (Prof. Bell) could not show conclusively from actual observation of the process, that *Bipalium* did divide in this manner, yet he thought he had obtained evidence sufficient to warrant the belief that such was the case. He received some time ago two specimens from Gosport (drawings of which he had made upon the black-board); one of them had the hammer-head shape at the one end, but the other, which was a very small specimen, had no trace of it, but was simply pointed at both ends. Unfortunately one of the Gosport specimens got lost, but he watched the small one carefully day by day, and on the 5th of October —or eleven days after it had arrived—he noticed a delicate fringe running round the anterior end. This fringe had since grown and grown until at the present time it was very obviously a hammer-head, so that it was clear that a creature of this kind might in the course of three weeks attain the perfect condition. A specimen from Liverpool, which had been divided into two in the post, was afterwards found to be in three pieces. At first he thought the third might have been previously overlooked amongst the moss, but on measuring the portions he found one to be 27 mm. and the other 16 mm., so that it seemed tolerably certain that at some period between the 29th of September and the 5th of October the piece which had originally measured 41 mm. had divided into two. He thought it might be conceded that the observations proved—first, that spontaneously a piece of a *Bipalium* would divide into two—and, secondly, that given repose, a piece of a *Bipalium*, pointed at both ends, would thicken and form the hammer-head extremity which was a characteristic of the adult.

Prof. Stewart, in reply to the President, said he had no remarks to make with reference to this very interesting communication, but he might perhaps mention that having had the opportunity of seeing the specimen which had reproduced its head, he had no hesitation in saying that it was a *bonâ fide* head. He could therefore entirely confirm the observation, although he need hardly say that confirmation was quite unnecessary in the case of so able and minute an observer as Prof. Bell.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—Tailed larva of Liver Fluke (*Fasciola hepatica*).

Mr. Cheshire:—*Spirococcus*, stained.

Mr. Crisp:—Microscope made by G. Adams, senr.

Dr. Crookshank:—Negatives showing flagella of Vibrio.

Mr. Curties:—Abbe-Zeiss Apochromatic Objectives for English (250 mm.) and Continental (160 mm.) tubes, 1 in., 2/3 in., 1/4 in., 1/6 in. dry, 1/10 in. water-immersion, and 1/8 in. and 1/12 in. homogeneous-immersion. Also compensating eye-pieces, magnifying 2, 4, 8, 12, 18, and 27 respectively.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Henry L. Brevoort, Alexander Collie, M.D., S. W. Dennis, Prof. Manly Miles, Charles West, and Frederick Wright.

Meeting of 10th November, 1886, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 13th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Microscope and Accessories (by Swift), and cabinet of slides ..	*The late Miss Tucker.*
Hudson, C. T., and P. H. Gosse, The Rotifera or Wheel-Animalcules, Part VI., pp. 97–144, pls. 26–30 (8vo, London, 1886)	*The Publishers.*
Slide of *Arachnoidiscus*, gold-plated	*Dr. A. Y. Moore.*

Mr. Crisp said that the Fellows would probably remember that some time ago they received a Microscope from the executors of the late Miss Tucker. It had been since discovered that the comparatively inferior instrument then received was not the one bequeathed to the Society, but the much larger and more valuable Microscope which, together with a box of apparatus and a cabinet of objects, was on the table, and was likely to be very useful to the Society.

The President thought that such a donation should be the subject of a formal acknowledgment, and therefore put to the meeting a motion for giving the thanks of the Society to the executors for forwarding the instrument.

Mr. T. C. White exhibited an album of photo-micrographs of a great variety of objects, including also some photographs of the apparatus employed, which was very simple. It was so contrived as to be used either as a projection Microscope or a camera.

Mr. Crisp, referring to the interest which still attached to the work done by Leeuwenhoek with his Microscopes, exhibited two facsimiles of those instruments. A collection of them was formerly in the possession of the Royal Society, but had disappeared, probably thrown away by some one unfamiliar with their form. The drawings of them gave only a very poor idea of what they were like, and it had been with much interest that some of the Fellows had had an opportunity of inspecting one of the original Microscopes brought to England during the recess by Prof. A. A. W. Hübrecht, the eminent Dutch zoologist, who to other accomplishments added that of a most extraordinary mastery over the English language both as regards grammar and pronunciation. Copies of the Microscope had been made by Mr. Mayall, which were so close a resemblance to the original that only by the closest examination was it possible to say which was which.

Mr. Crisp also exhibited Golfarelli's Micrometric Microscope for the special use of watchmakers in examining the teeth of very fine escapement wheels, and commented on the wide field that was opening if special Microscopes were going to be made for the different purposes to which they could be put. He also exhibited Cailletet's apparatus for examining the effects produced upon minute aquatic organisms by enormous pressures up to 650 atmospheres, necessitating great strength in the apparatus. He also called attention to two "telescopic" objectives belonging to Prof. Abbe, so arranged that the image of the object was not altered in size by varying the length of the draw-tube, a matter of importance in the case of micrometric measurements.

Mr. J. Mayall, jun., called special attention to the exhibit of Mr. T. Powell, who, not wishing to be behindhand in the matter of objectives, had procured some of the new glass from Jena, and had worked out an apochromatic 1/12 in. objective on his own formula. In the result he had produced an objective which certainly compared very favourably with those of Zeiss which had been exhibited in this country. The Fellows could see for themselves how extremely well this objective stood the tests applied to it, and it should be specially remarked that the eye-piece used with it had a magnifying power of 40, and the lens showed no sign of breaking down under it. This it would be remembered was a much higher power than the highest (27) in the Zeiss series. He believed the eye-pieces were made on a formula analogous to that of Zeiss, though not quite the same. The formula of the objective was evidently less complex than that of Zeiss; there were fewer lenses and hence less difficulty in construction. The meeting would, he was sure, be gratified to know that directly the new glass was available, one of their Fellows had put his shoulder to the wheel, and produced such first-class work as the sample before them.

The President said he had had the opportunity that evening of examining this new lens of Mr. Powell, and he could only say that he was quite astonished at the definition which it gave. Even under the

highest power eye-piece it gave almost, if not quite, as perfect an image as those produced with lower eye-pieces. Since the date of their last meeting he had been afforded the opportunity of examining very carefully a set of the new lenses made by Zeiss, together with a new and complete set of eye-pieces, and whilst he was perfectly convinced of the immense gain which objectives of that construction would be to the microscopist, he was also perfectly sure that serious errors would be introduced unless they were made by the best makers. It would be interesting to know that Mr. Mayall had also made a critical examination of these lenses quite independently and had written down the results, and that when these were afterwards compared with the observations he had himself recorded, the two sets of results were found to be almost exactly coincident. It was also a matter for great satisfaction that Mr. Powell had added to the value of his objective still further by increasing the power of his eye-pieces with such excellent results. Except in one single instance, he had never seen the test-objects shown better.

Mr. Cheshire thought Mr. Powell was greatly to be congratulated upon the success which he had attained, as the definition of the objects exhibited by him under such a high power was magnificent. It was, however, extremely difficult to compare the one with the other at a distance, and he suggested that a committee might be appointed to make comparisons under favourable conditions.

Mr. Crisp said that if Fellows wanted to see the two objectives on the same evening, they would be able to do so at the Conversazione on the 24th instant, but he was afraid the suggestion of Mr. Cheshire could not be acted upon. Something of the kind had been done on a former occasion, and it was found to produce more harm than good.

Mr. Watson exhibited a new form of histological Microscope, the principal feature of novelty in which was two raised edges upon the stage to carry the slide, which was thus prevented from scratching the surface of the brasswork, and in consequence of the reduced size of the points of contact could be moved about with much less than the usual amount of friction (*supra*, p. 1046).

The President said this little improvement was so simple and effective, that it would no doubt commend itself to all who saw it.

Mr. C. Beck explained the additions which had been made to the portable National Microscope, one of which he exhibited.

Mr. S. O. Ridley read a paper "On the Classification and Spiculation of the Monaxonid Sponges of the 'Challenger' Expedition," illustrating his description of the various typical forms by drawings on the black-board.

Mr. A. Dendy also read a paper "On the Anatomy and Histology of the Monaxonid Sponges of the 'Challenger' Expedition," the subject being illustrated by drawings and specimens.

The President said the details concerning this group of sponges,

which had been given in the two papers before them, were certainly very full and valuable, and he very much regretted that, owing to the lateness of the hour, it was impossible to afford time for their discussion. The authors, however, were to be much congratulated on the lucidity of their explanations that evening.

Dr. E. M. Crookshank gave a *résumé* of his paper on the Surra parasite, under the title of "Flagellated Protozoa in the Blood of diseased and apparently healthy Animals," which he illustrated by drawings, photographs, and specimens exhibited under the Microscope (*supra*, p. 913).

The President regretted that time did not permit them to give a proper discussion of this subject, which was evidently of great interest and practical importance, and Prof. Bell referred to previous papers of Bütschli.

Dr. Crookshank said that it was rather a disadvantage to discuss the subject of a paper only parts of which had been read; but when the paper was before them *in extenso*, they would see that he had not overlooked what Bütschli had said. At that late hour of the evening (10.10 P.M.) it was not possible to pursue the matter further.

The Conversazione was announced for the 24th November.

The following Instruments, Objects, &c., were exhibited:—

Prof. Abbe:—"Telescopic" objectives.

Mr. C. Beck:—Improved Portable National Microscope.

Mr. Bolton:—*Urocentrum turbo*.

Mr. Crisp:—(1) Leeuwenhoek Microscopes. (2) Cailletet's Microscope for high pressures. (3) Golfarelli's Micrometric Microscope for Horologists. (4) Jung's and Zentmayer's adjustable diaphragms.

Dr. Crookshank:—Specimens, drawings, and photographic transparencies illustrating his paper on the Surra parasite.

Mr. A. Dendy:—Specimens in illustration of his paper on 'Challenger' Monaxonid Sponges.

Dr. A. Y. Moore:—*Arachnoidiscus* gold-plated.

Mr. T. Powell:—New Apochromatic hom. imm. 1/12 in. Objective.

Mr. S. O. Ridley:—Specimens in illustration of his paper on 'Challenger' Monaxonid Sponges.

Mr. Watson:—New Histological Microscope.

Mr. T. C. White:—Album of Photo-micrography.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Alexander Maubré, James A. Ross, M.D., Rev. William Spiers, M.A., and Wallace A. White.

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